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CONTENTS.

Page

EDITORIAL 133
THE TEACHING OF BIOCHEMISTRY IN THE MEDICAL CURRICULUM—By Prof. H. Wasteneys, F.R.S.C. 135
ANATOMY AND PHYSIOLOGY OF THE CORONARY CIRCULATION OF THE HEART—By H. F. Robertson, M.D. 136
THE TREATMENT OF ADDISON'S DISEASE—By R. A. Cleghorn, M.D. 143
CASE REPORT—By B. F. Hazlewood, M.D. 146
BONE TUMOURS; PART I.—By W. L. M. King, '37 149
BONE TUMOURS; PART II.—By Ross Campbell, '37 152
GOITRE—By D. H. McKAY, '37 156
SOME SURGICAL INFLAMMATORY DISEASES OF THE KIDNEY—By Gwen S. Hudson, B.A., '37 161
LYMPHATICS OF THE HEAD AND NECK—By Oscar Hoffman, '39 165
THE SKELETAL SYSTEM—By J. G. Mickler, '41 168
FEATURE SECTION: A SUMMER AT HARRINGTON HARBOUR, P.Q.—By J. D. Caldwell, '37 173
BOOK REVIEW 175

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Finances have and always will loom as a large and worrying factor in the education of young doctors. It is appropriate that all possible means of reducing this expenditure be inquired into. Unlike most university trainings, medicine is a long and tedious grind. Its length adds to the financial burden. Its fees are the highest among the faculties. Moreover, following graduation, it is beset with expenditures and is slow in bringing in ready returns. It is throughout the period from the commencement of his medical education until a practice is established that any means available for lightening the burden will be appreciated by the young doctor.

It is not intended here to set forth the advantages to be derived from good books and good instruments at a time when the student is learning and preparing investments for the years to come. Suffice it to mention the matter. What may not be apparent and what on thought is not at all surprising is that many good students are unable to purchase even the necessary texts. Reading is broadening and in the interests of the profession, students should be encouraged to do more than read notes.

Moreover, it is not sufficient that such books be available in the libraries. Time is a precious factor, and it becomes difficult, almost impossible, to hurry back and forth to libraries for books which may be used only moments in the evening, precious moments though they may be. It is likewise fair that overnight library books, usually in great demand, should be taken out as seldom as possible and used to full advantage at that time. It is shameful to take out such books for the express purpose of preventing a class-mate from doing so. Again it is often impossible to determine beforehand what books will be required for the evening or week-end's reading. In the clinical years, especially Sixth, the use of the library is almost debarred from many for at least a portion of the year, as some of the teaching hospitals are none too centrally located.

The functions of a library should be essentially reference. It should be the abode of thoughtful minds. The regular perusal of its shelves should be encouraged as a habit. It is not unfair to say that our Medical Reading Room meets these requirements poorly. Study between the hours of four and six, to say the least, is impossible because of the endless parade of borrowers of standard and prescribed texts.

Students take delight in the possession of good books. These should be as much a part of his accoutrements as notebooks themselves.

Instruments likewise are expensive, and often unreliable firms take the opportunity of under-cutting the business of well-established houses, and of unloading upon the students inferior goods. In addition, staff members are continually being worried excessively by students enquiring as to the quality and up-to-dateness of the goods they have been offered. Many is the occasion upon which unsatisfactory goods have been purchased because this privilege was not indulged in.

It is for all these reasons that more centralized distribution of medical texts and supplies at cost price should be instituted. Other well-advanced centres of learning have this established. It is pitiable that the University Supply Room should be undersold by firms who have profit as their only motive. Surely the University Press should be to the advantage of students by more than its convenient site.

If profits can be made on the sale of text-books and supplies, should they not be made by and returned to the student body, whose demand makes their preparation profitable? If this is true of cheap texts, should it not be all the more true of expensive volumes? Moreover, there are many students needy and willing who could be advantageously employed in this business.

With such a centre, savings to students of 30% would not be unreasonably expected. There would be more widely available to all, standard and approved texts. It would give students a fool-proof House of Supply, where they would not be sold a fifth edition at regular price, without knowing that the seventh edition would be available within a week's time. Instruments could be standardized and be brought to meet the individual requirements of professors. Inferior goods would not be sold. Needy students would be able to help themselves.

The time for establishment of a House of Supply for medical books and supplies is at hand to make a new landmark in student co-operation.

THE TEACHING OF BIOCHEMISTRY IN THE MEDICAL CURRICULUM.

By PROFESSOR H. WASTENEYS, Ph.D. (Col.), F.R.S.C.,
Professor of Biochemistry.

It is the purpose of the medical curriculum, as we conceive it, to so train the student that he may not only become proficient in the art of medicine, but, above all, that he may base his approach to the acquirement of this proficiency on a profound realization (to paraphrase Claude Bernard) of the harmony, regularity, and constancy, by which vital phenomena, rigorously determined by physico-chemical conditions, bring about the organization, growth and normal functioning of the organism.

We conceive it to be the part played by biochemistry in the curriculum that it serves, with physiology, to integrate and extend the knowledge of natural phenomena which has been acquired by the student in the previous courses in physics, chemistry, anatomy and biology into a comprehensive appreciation, so far as present-day knowledge permits, of the mechanisms which control and co-ordinate normal function in the organism as a whole, and to serve in turn as a foundation on which to build the knowledge he must later acquire of abnormal function and the means by which it may be controlled.

The course in biochemistry also fulfills, in common, we hope, with all other courses in the curriculum, another important purpose. That of illustrating, by repeated examples, the methods by which the biochemist elucidates vital phenomena, the scientific methods of hypothesis, observation and experiment. Dr. Abraham Flexner states somewhere in his book on the subject, that "Medical Education is the effort to train students (of Medicine) in the intellectual technique of inductive science," for, he points out in another place in his book, "just as the investigator obviously observes, experiments, and judges, so do the physician and surgeon, who practice their art in the modern spirit."

These two purposes which it must serve are the inspiration, then, for the course in biochemistry and, as the exposition of the chemical and physico-chemical phenomena concerned in the constitution and normal functioning of the human organism proceeds, they should be continually kept in mind. Accordingly, throughout the whole course, the endeavour is made to stress principles rather more than conclusions and to inculcate a scientific approach to the problems of biochemistry. While, in the lectures, conclusions which have been reached as to the biochemical principles, which underlie function are outlined, the experimental procedure by which accepted conclusions have been reached are as fully described as time permits. The endeavour is made to effect a compromise between teaching a collection of accepted facts and impressing on the student that the fundamental facts of medical science are in many instances not yet finally established and that in almost every direction their confirmation awaits the application of further research.

Because the course deals largely with the purely chemical aspects of function and because in the previous course in organic chemistry there is no time to deal with more than the fundamental aspects of this science, the biochemistry course in its earlier parts proceeds to consolidate the student's knowledge of organic chemistry and to emphasize the applications of this science to the elucidation of biological phenomena. The purpose in commencing in this way is twofold. Not only is the need for a considerable familiarity with organic compounds and reactions stressed, since this is essential to the main purpose of the course as well as to an understand-

ing of the methods by which the exact chemical structures of such clinically important substances as the hormones and vitamins have in some cases been ascertained and their synthesis in the laboratory accomplished, but, moreover, a review of the chemistry of the carbohydrates, fats and proteins serves as a review of the proximate constituents of food and consequently of the body tissues. Biochemistry, at any rate a major portion of the subject, is in fact a continuation of the course in organic chemistry. The knowledge previously gained of the principles of physical chemistry is also reviewed early in the course by consideration of its applications to such fundamental biological phenomena as absorption, the water balance of the body, the transportation of carbon dioxide in the blood, the preservation of the neutrality of the blood and tissue fluids, the activity of enzymes, haemolysis, and oedema.

The lecture course consists of a description of the chemical and physico-chemical structure of living organisms, the chemical correlation of tissue activity, the reactions which underlie the various manifestations of life, the products characteristic of the vital processes, the chemical and physico-chemical methods which may be used to solve biological problems and the nutritional requirements of animal organisms.

These are described, of course, particularly as they apply to the human organisms with the main purpose of enabling the medical student to get a thorough understanding of the fundamental chemical and physico-chemical phenomena underlying normal body function. References to abnormal function, while made occasionally when they may elucidate normal function, are not stressed for the reason that the application of these principles to the study of abnormal function is dealt with in the later course of Pathological Chemistry.

The laboratory course may be briefly described as divided into three main parts. In the first part, the student is familiarized with the chemical reactions and procedures which are used to determine the composition of biological material; in the second part, the knowledge and skill acquired in the first part is applied to elucidate and familiarize the student with the distinctive chemical characteristics of typical organs, tissues, and biological fluids; and in the third part, the chemical reactions of the alkaloids are studied and a number of quantitative methods commonly used in biochemistry are practiced by the student.

ANATOMY AND PHYSIOLOGY OF THE CORONARY CIRCULATION OF THE HEART.

By H. F. ROBERTSON, M.B.

Disease of the heart to-day holds a leading place as a cause of death. A large number of these cardiac deaths are closely associated with coronary arterial disease. It is appropriate then that interest in the circulation of the heart should have become a subject for intensive study in all branches of medical science and that, because of this awakened interest, progress has been rapid and productive of much useful knowledge. In the following short review, the usual facts pertaining to the anatomy and physiology of the coronary circulation will be stated, recent concepts being added where possible. Points which bear on the more common cardiac diseases will then be discussed from a clinical-pathological viewpoint.

A brief preliminary description of the anatomy and physiology of the heart's blood supply may be helpful before proceeding in more detail.

The right coronary artery supplies the right heart except for a strip of right ventricle anteriorly which approximates the anterior or superior interventricular sulcus. It also supplies from a third to a half of the posterior aspect of the left ventricle approximating the posterior or inferior interventricular sulcus. The right heart is drained by various veins which run alongside the arteries to the auriculoventricular groove and empty into the right auricle, a few proceeding further behind to join the coronary sinus as it nears the right auricle. The right heart wall, which is thin and much trabeculated, is further drained by the thebesian veins and the venae cordis minimae directly into the right heart cavities. The right coronary artery carries about one-third of the total coronary inflow, the veins of the right heart a small percentage of the total cardiac venous outflow, while the thebesian system of the right heart carries off about 30% of the total cardiac venous outflow, or, in other words, a large part of the right heart venous blood. The left coronary artery supplies the left heart except for a strip of the left ventricle along the posterior interventricular sulcus. It also supplies about one-third of the anterior surface of the right heart which approximates the interventricular sulcus. The veins of the left heart are arranged in a very definite system, commencing with the great cardiac vein, which, starting at the apex of the heart, parallels the anterior descending branch of the left coronary artery to the region of the left auricular appendage. There is proceeds to parallel the circumflex branch of the left coronary artery and, being joined by the veins of the other left coronary vessels, the coronary sinus is eventually formed in the auriculo-ventricular groove behind the left auricle. The sinus runs in the groove to terminate in the right auricle near the sulcus terminalis. The left coronary artery inflow is about 70% of the total coronary flow, while of the venous outflow, nearly 90% is carried off by the veins and very little by way of the thebesian vessels, which are poorly developed in the left ventricle. The venous outflow from the left heart through the coronary sinus is usually 60% to 90% of the total venous return to the right auricle and this percentage remains remarkably constant for any one heart. The arterial inflow of the heart occurs during diastole while the walls are relaxed, systole serving to cut off the inflow and squeeze the blood from the heart walls back to the right heart through the routes above mentioned. A rather special system of arterial vessels is made up of minute arterioles coursing through the fat which occurs to a greater or lesser extent under the epicardium of adult hearts. These vessels are known as the rami telae adiposae and spread a richly anastomosing network of vessels over the heart, which in coronary occlusion and stenosis helps bridge gaps in the coronary circulation. The thebesian system of vessels, mentioned above, are likely only useful for hastening drainage of the heart wall by rapidly shunting venous blood back into the right auricle and ventricle and are thus found mostly in the right heart wall. The conducting mechanism of the heart has several important vessels supplying it, which, when closed, may give rise to definite disturbances in cardiac rhythm. Lastly, in many hearts, some or all of the valves have a definite blood supply derived from various vessels, but mostly from those in the septum of the heart. It is thus seen that during diastole arterial blood rushes into the arterial system of the heart and is distributed to the heart wall and to other structures, while in systole, the blood is squeezed from the heart wall, either into the veins and back to the right auricle, or directly by the Thebesian veins, mostly into the right heart cavity, from whence it is sent through the lungs again for re-oxygenation.

A more detailed description of the above circulation might be as follows:

The right coronary artery arises from the anterior aortic sinus, runs for-

ward between the pulmonary artery and the right auricle to reach the auriculo-ventricular sulcus under the ear of the right auricle. It then follows the sulcus to the crux of the heart behind, where it sends down an interior branch in the inferior longitudinal sulcus to the apex, while in 80% of cases, its main course continues across the crux for a short distance in the posterior portion of the left auriculo-ventricular sulcus. The vessel is here known as the circumflex branch or the ramus ventricularis sinister. It ends by anastomosing with the terminal twigs of the circumflex branch of the left coronary artery. Almost at its origin, the right artery gives off several small twigs which run upward on the aorta, in its adventitia, to anastomose with aortic vasa vasorum arising superiorly from numerous and various thoracic vessels. Anastomoses are also made with small vessels passing to the aorta betwen it and the pulmonary artery from the first part of the left coronary artery, and with still other branches which arise from the descending branches of the left coronary artery and pass to the right across the conus arteriosus. The next branches of importance are several large ones which pass across the conus arterosus towards the anterior descending branch of the left coronary artery to anastomose with it. Several others are seen at the acute margin of the heart and run along the lower margin of the right ventricle. The largest of these is known as the marginal branch of the right coronary artery. Smaller vessels are given off to the auricle above from variable points in the course of the main artery. In the region of the crux, still other small branches go above to the auricle and the great vessels at the base of the heart, besides the main vessels noted above, called the inferior or posterior descending branch of the right coronary and its circumflex branch to the left ventricle. The inferior or the posterior descending branch, as it runs towards the apex of the heart in the inferior or posterior longtitudinal sulcus, gives off many branches at right angles to the main stem. These branches run into the septum of the heart in a fan-like fashion and anastomose in the septum with similar branches from the anterior descending branch of the left coronary artery. The termination of the right coronary artery is usually, as mentioned previously, on the posterior portion of the left ventricle, where it runs in the auriculo-ventricular groove for a short distance before turning down over the left ventricle. Its terminal twigs anastomose with those of the circumflex branch of the left coronary artery. Sometimes the terminal twigs go well along the posterior aspect of the left ventricle before terminating, accounting for two to three vessels on back of the left ventricle, while, in other cases, about 20%, they do not pass the posterior interventricular groove.

The left coronary artery arises from the left posterior aortic sinus and runs between the left auricle and the pulmonary artery to the commencement of the anterior longitudinal sulcus, where it divides, under the left auriclar appendage, into its main branches, an anterior descending and a circumflex. Almost at its origin, a variable number of small vessels are given off to the aorta and the pulmonary artery, where they anastomose with the vasa vasorum of these vessels, and through them form a potential anastomosis with various thoracic vessels. One of the vessels is often quite large and courses between the aorta and the pulmonary artery to establish a connection here between the left and right coronary arteries. The anterior descending branch passes towards the apex of the heart in the anterior or superior longitudinal sulcus, giving off in its course several lateral branches which anastomose across the coronary arteriosus with branches of the right coronary artery. Vessels are also given off, at right angles to the course of the vessel, into the septum, where they anastomose with similar vessels from the posterior descending branch of the right coronary artery. Other branches pass toward the left

border of the heart to anastomose freely with twigs of the anterior descending vessels and with twigs from the vessels of the posterior border of the left ventricle.

The mural or muscular and the endocardial branches of the above vessels show an important difference in distribution between either side of the heart. On the right side, the mural branches run into the heart wall from the epicardial surface more or less obliquely. In the muscle wall, small twigs are distributed so that each muscle fibre is liberally supplied. At the endocardial surface, terminal vessels branch to form a network close to the endocardium. The mural branches on the left side leave the main stem at right angles in contrast to the more oblique branchings of the right heart main vessels. The branches run straight into the heart muscle, to there give off further twigs again at right angles, which supply each muscle fibre generously. The left wall being thick, it is thus seen that, because of the branchings at right angles, the main epicardial vessels are firmly anchored in position, a circumstance the significance of which will be discussed below. The terminal endocardial twigs are close to the endocardium running parallel to its surface.

There are now left for description several parts of the coronary circulation, which, though they may appear of minor importance superficially, will be shown later to be in reality of much interest. The vessels known as the rami telae adisposae, which infiltrate the fatty epicardial covering of the heart, particularly about the great vessels and the base of the heart, form a network over the larger coronary vessels. They serve as anastomotic vessels between the various large branchings of both coronary arteries and also between the vasa vasorum of the pulmonary arteries and the aorta and the coronary vessels. They are scarce in early life, but with age and its usually attendant coronary sclerosis, as the fatty deposits thicken at the base of the heart and gradually spread along and over the large vessels, and across the rich anastomotic area of the conus arteriosus, they become very numerous and are of importance in maintaining adequate nutrition.

The vessels of Thebesius and Vieussens were described by these men in the latter part of the 17th century. The Thebesian vessels connect the venous network of the heart wall with the heart cavities. They are found mostly in the right wall, but some are also present in the left ventricular wall, while most workers agree that there are none, or very few, in the wall of the left auricle. They not only connect with veins, but they also connect with small terminal branches of the coronary arteries. They were said by Thebesius to be useful for the rapid emptying of the heart wall during systole and, as will be noted below, this still appears to be their only function. The vessels of Vieussens, on the other hand, connect arterial vessels with the heart cavities. Only in this manner do they differ from the Thebesian system. Indeed, the two should be considered as one system of vessels which have various sized openings into the heart cavities and which during the systolic contractions of the heart, serve to quickly empty the walls and, at the same time, because most of the vessels empty into the right heart, quickly return the coronary blood to the right heart cavities and thus to the lungs for re-oxygenation.

The blood supply to the conducting mechanism of the heart is derived mostly from the right coronary artery. The sino-auricular node is supplied by a special branch of the right coronary artery in most cases; though occasionally the vessel spings from the left coronary artery. The vessel is known as the ramus ostii cavae superiorus, and it runs from near the origin of the right coronary artery along the top of the right auricle near the interauricular septum to send branches circulating around the sulcus terminalis and the sino-auricular node. The auriculo-ventricular node is nearly always sup-

plied by branches from the right coronary artery also, the most important vessel being the ramus septi fibrosis, which is really a high branch of the septal vessels and arises near the crux from the circumflex branch of the right coronary artery and runs anteriorly between the interventricular and interauricular septi to anasmotose with a similar branch from the left coronary artery. It branches to follow the two bundles throughout their course. Anasmotoses with other septal branches are common and are often capable in the usual heart of carrying on a sufficient circulation for function in case one of the main vessels to the conducting system is interfered with.

The valves of the heart have been held by many to possess a definite blood supply derived from specific vessels. Some thought that vessels found in valves were merely the result of previous inflammatory changes, or were the relics of embryonic vessels accidentally left only occasionally; while others felt that besides this, the presence of muscle fibres, in connection with vessels in the valves, showed that the valves had not progressed past early development and, for this reason only, maintained a blood supply. The largest vessel supplying the valves is derived from the right circumflex coronary branch posteriorly and runs forward to anastomotose with similar branches of the left coronary circumflex branch. It is called the arteria anastomotica auricularis magna. It anastomoses above with aortic vessels. The mitral and tricuspid valves are often supplied by twigs from auricular branches of either coronary artery.

The venous system of the heart needs for present purposes little enlargement on what was said above. The right side of the heart has a rather small and poorly developed system of veins. Anteriorly, veins accompany the several arteries to the coronary sulcus and empty into the auricle directly; while more posteriorly a vein along the right margin of the heart, called the marginal vein, joins one or two other veins of similar situation to form the small cardiac vein emptying into the coronary sinus. On the left side veins accompanw the larger arteries of the anterior and left lateral surface of the left ventircle to end in the great cardiac vein which commences at the apex of the heart and parallels the anterior descending branch of the coronary artery to the region of the left auricle. It then continues in the coronary sulcus posteriorly, becoming the coronary sinus when it receives the oblique vein of the left atrium on the posterior or inferior aspect of the heart. The sinus receives several posterior veins and a large vein from the inferior longitudinal sulcus called the middle cardiac vein.

It was mentioned above how the coronary inflow occurred during diastole and how the heart walls were emptied during systole. The heart supplies itself with one-fifth of the blood it pumps into the aorta and here it should be pointed out that the diastolic blood pressure is most important to coronary circulation, for on it depends the force of the coronary inflow. The length of diastole, as well as the force of the inflow, is also important, of course. During exercise, the coronary flow is increased as much as ten times over normal flow. Though blood pressure increases the coronary inflow four times, accelaration of the heart rate, tissue metabolites, arterial oxygen and carbon dioxide content changes, various hormones, and nervous reflexes also influence the rate and volume of the coronary circulation. With acceleration of the pulse, coronary inflow is usually increased, other factors remaining the same, for cardiac output is increased; a rapid rate with short diastole and low pressure would, of course, result in poorer coronary inflow. Lactic acid and other products of tissue metabolism serve to dilate the vessels, while anaxoemia also usually produces a like effect. Adrenalin accelerates the pulse and increases the coronary flow. It is said to dilate the coronary vascular

bed. The coronary arteries are very well supplied by a dense nervous network derived from both the vagus and the sympathetic nerves. The vagus effect is one of cardiac slowing, with a coronary inflow decrease, and constriction of the coronary bed. The sympathetic effect is the opposite. It has not been definitely established just what part of the coronary bed dilates or constricts, but it is thought that the larger vessels act differently than do the smaller intramural branches. The coronary flow is thus seen to be under local metabolic control, as well as under the influence of extrinsic reflex, metabolic, and hormonal changes, which co-ordinate the cardiac blood supply with the various changes in cardiac activity demanded by the body as a whole.

Discussion.

The most important questions relating to the circulation of the heart are undoubtedly coronary sclerosis, coronary occlusion and stenosis, which are portrayed clinically by chronic degenerative myocarditis, coronary thrombosis or angina pectoris. The pathology of coronary sclerosis in itself is very interesting, but of perhaps even more interest and importance is the study of the way in which nature attempts to compensate for the lesion. The left coronary vessels are the ones most frequently mentioned in relation to coronary sclerosis and ensuing heart damage, for they are more frequently and severely diseased than are the right coronary vessels. Thrombosis is most frequent in the left anterior descending branch. Some think that the left coronary vessels, and particularly the left descending branch, possessing branches which run into the heart wall markedly at right angles to the main vessels and thus anchor them firmly, develop both endarteritis and medial sclerosis at the point of branchings, due to undue strain and stress in these regions. However this may be, it is true that thrombi are commonly found based on a plaque sitting at the mouth of one of the mural branches. Infarction following such a coronary closure due to thrombosis depends for its extent on the adequacy of the anastomotic circulation mainly, which depends on the size and location of the vessel occluded, the duration and rapidity of closure, the age of the patient; and the ability of the blood to carry oxygen, i.e., the presence or absence of anaemia. It has been demonstrated that the rami telae adiposae can successfully bridge very much narrowed portions of the coronary circulation and thus prevent infarction. The fat pad vessels are most certainly more numerous with advancing years, but their number also seems to bear a relation to disease incidence in that they are found more prolific when coronary sclerosis is well advanced, regardless of age. The extent of anastomoses between the various coronary terminals varies a great deal and is of importance. It has been shown that around an infarct, an active vasodilation takes place and vessels enlarge to increase circulation to the damaged region. It seems that age and probably disease tends to increase these anastomoses in an effort to prevent further damage by advancing sclerosis. Experimentally, and in some cases clinically, it has been shown that the vasa vasorum of the aorta and pulmonary arteries helped provide circulation to the heart by virtue of their connecting the coronary vessels with various thoracic vessels.

For a time the idea was popular that a certain amount of nourishment could be provided to the heart wall by a flow of blood from the heart chambers into the Thebesian vessels or into the vessels of Vieussens and thence into the intramural capillary network. The positive evidence for such a source of nutrition was meagre and problematic. A period in the cardiac cycle during which intramural pressure was below the pressure in the heart chambers was presupposed and such a supposition is not supported by physiological fact. An idea that the left heart might be nourished by a backflow of right heart

blood along the coronary sinus has not gained support.

Recently experimental work has shown that the coronary circulation of the heart can be reinforced by joining it to various structures containing blood vessels. Thus anastomoses with the coronary vessels are formed. Operations of a like nature have now been done on a group of humans suffering from the symptoms and signs of coronary occlusion and stenosis. It has been shown that an anastomotic blood supply can actually be established and will with certainty benefit many patients for a time at least. The value of the procedue is still to be decided, however, for coronary sclerosis is notorious for its inevitable progress, and, further, the anastomosed vessels in the tissues mobilized and grafted to the heart are very liable to closure by the development of scar tissue.

Valvular disease of the heart is now thought, in many cases, to be due to blood vessels which remain patent in the valves and carry organisms to the leaflets. Thus, in a series of cases of malignant endocarditis, it is common to find the vascularized valves affected, while nonvascular valves are not affected so frequently. Rheumatic fever, although not showing such close correlation between vascularity of the valves and disease incidence, probably also depends for its localization on vascularization.

Disturbances of the heart beat, such as bradycardias, branch bundle block, or complete heart block, have been demonstrated in many cases to be due to a closure of the vessels supplying either the sinus or the bundle of Hiss. Either embolic or stenotic disease may be the factor. It is very likely, however, that in many cases disease of these vessels has become advanced without causing disturbances in rhythm because of the rich anastomotic supply about the sinus and about the bundle of Hiss and the auriculo-ventricular node.

The venous system of the heart does not seem to play an important role in cardiac disease. Developmental anomalies, such as junction between a small artery and the coronary sinus, or complete closure of the coronary sinus near its entrance into the right auricle, are among those reported, and in such cases, no disturbance of the heart due to this cause was noted during life. This is undoubtedly so because of the very ready anastomoses between the venous vessels on the outer surface of the heart and the profuse venous channels of the wall, which, especially on the right side, lead into the cavity of the heart and provide adequate venous drainage.

Lastly, the question of whether neurogenic disturbances are capable of greatly disturbing cardiac nutrition may be mentioned. Some believe that an imbalance between the vagus and the sympathetic systems can, by overaction of either, produce definite changes in the coronary vessels. It has recently been shown that the continued administration of vagus substance or acetyl-choline is capable of producing marked amounts of coronary damage. On the other hand, it is hard to believe that when marked sclerotic disease of the coronary arteries is already present, spasm of the vessels can occur so that so-called spastic occlusion of neurogenic origin is not so likely from a theoretical standpoint, and is, of course, difficult to prove from the clinical or practical viewpoint.

THE TREATMENT OF ADDISON'S DISEASE.

By R. A. CLEGHORN, M.D., D.Sc., Aberd.

Understanding of the pathological psysiology of Addison's disease has been essential for the development of effective treatment of this malady. Such knowledge as we have to-day enables us to bring these patients through the crises that characterize the disease and to give them a measure of strength during the remissions not possible seven years ago. This implies, however, the full co-operation of the subject, without which treatment is of little avail. How much the life span of these victims of an hitherto progressive and fatal disease can be prolonged is impossible to say at present. Their great sensitivity to infection or poison of any sort, in spite of treatment, makes every minor illness a situation fraught with danger.

In the development of our knowledge of adrenal physiology, the interdependence of the clinician and laboratory worker is well exemplified. Clinical acumen recognized the syndrome of adrenal insufficiency in man, but further progress was delayed until the introduction of asepsis and anaesthesia in surgical practice made possible the operative procedures by which physiologists determined that it was the cortex rather than the adrenalin-producing medulla which was essential for the life of the animal. This fundamental point established, biochemical investigations revealed the characteristic changes in the blood in adrenal insufficiency to be: increase in the non-protein or urea nitrogen; reduction in serum volume; rise of potassium and fall of sodium and chlorides in plasma or serum. The preparation of an extract of adrenal cortex capable of reversing these changes and of prolonging the life of adrenalectomized animals was effected in the years 1927-1930. Finally, a most important therapeutic procedure was introduced by a clinician, Robert Loeb, in 1931, who demonstrated the beneficial effect of administering diets high in sodium chloride to patients with Addison's disease.

Diagnosis.—This, in the majority of cases, is relatively easy when the characteristic signs and symptoms are marked. Then the asthenia, history of gastro-intertinal disturbances, pigmentation typically accentuated over joints and occurring on mucous surfaces, and the low blood pressure mark the syndrome unmistakably. When, however, pigmentation is absent or masked by racial colouring or the blood pressure is found to be normal, as not infrequently occurs, restriction of the sodium chloride intake for a few days may establish the diagnosis. This procedure is not unattended by danger and should only be essayed when the patient is under the strictest surveillance, where observations of the general condition and frequent blood pressure readings may be made. The appearance of weakness, nausea or vomiting and, or, marked fall in blood pressure and serum sodium, calls for prompt treatment as for crisis. Occasionally patients with Addison's disease exhibit blood sugar values of an extremely low order and may become comatose on this account.

Treatment. — Long established general measures form the background for successful therapy. These are directed at avoidance of extremes of temperature, fatigue and infection, all of which make demands of the patient's inadequate reserve of strength and resistance. Because more specific measures have been recently introduced in the treatment of the disease, these points should not be lost sight of, and, though the patient's capacity for effort may be increased by modern therapeutic procedures, he must be advised to curtail his activities short of the appearance

of fatigue and to treat even trivial infections with respect and consult his physician at the onset. The diet should be adequate as to vitamins and calories and preferably high in carbohydrate. Cotton-seed oil, one to three ounces daily, is said to be of benefit. Avoidance of large amounts of food of high potassium content, such as meat products, is advisable. Alcohol should be taken only in strictest moderation or not at all, and drugs only when ordered by a physician.

When prescribing for a patient with Addison's disease, the physician must remember that these people are hypersensitive to drugs, so that minimal doses only should be employed. There should be little occasion for such remedies and this includes the barbiturates, which may constitute a serious menace to life in the Addisonian, probably on account of the slower excretion. Thyroid extract is contra-indicated, even though these patients often have a low basal metabolic rate; it will precipitate crises. Only rare cases suffer actual thyroid deficiency as well as adrenal insufficiency.

Surgical operations, even of a minor nature, should be undertaken only when imperative, and then the patient should be prepared by injections of large amounts of extract, and of saline as well if dehydration is present.

The cardinal features of treatment introduced by recent advances are the administration of sodium salts and adrenal cortical extract. The amount of extra salt required to maintain the blood sodium near the normal range and the tissues in a normal state of hydration is an individual problem and varies even in the same case from time to time. While blood sodium estimations are of value in adjusting this, they are not essential, and fortunately so, for the technique is difficult and time-consuming. The quantity usually employed varies from four to ten grams of sodium chloride and two to four grams of sodium citrate, taken either directly on the food or in fifteen-grain capsules at meal-time. This is in addition to the salt normally employed in seasoning. Sodium in the citrate form is given in addition to the chloride salt, since the loss of the sodium ion by the kidney in Addison's disease, which constitutes one of the major metabolic faults, occurs in excess of the chloride loss.

Evidence of the beneficial effect of high salt intake is observed in the rise of the blood pressure to more normal levels, increase in weight and strength. If the salt intake be in excess of the optimum amount, diarrhoea may occur or oedema of the dependent parts and soft tissues, e.g., about the eyes. Nausea and vomiting may also result, and one must be careful to distinguish this from the premonitary signs of crisis. While too much salt does no great harm, the consequent symptoms are distressing, and reduction in the added salt intake brings comfort. Awareness of the fact that some patients cannot tolerate sufficient salt to maintain tissue hydration is imperative. These patients, who probably have even less functioning cortical tissue, require cortical extract administered intramuscularly two or three times a week to maintain their lives, as well as a limited amount of extra salt. Since the extract causes salt and water retention, a rapid gain in weight may be observed with its administration. This must be controlled either by reduction in the amount of extract administered or of salt ingested.

Until recently, the extracts manufactured commercially have been very costly, sometimes toxic, and of such low hormone content that only by the administration of huge amounts could an effect be observed. Now, fortunately, these shortcomings have been remedied so that most are non-toxic. Potency of different preparations still varies considerably however, and since no standard of assay is uniformly utilized, the statement of the manufacturer that so many dog units are contained per cubic centimeter is almost meaningless. The preparation used here, made by the Connaught Laboratories, is fortunately free from these objec-

tions; it is non-toxic, adrenalin-free, and of uniformly high potency, and marketed at a reasonable price so that even cases having to take extract regularly are not subject to impossible expense.* Adrenalin has no place in the treatment of the disease.

Consideration of the details of treatment already described in a general way may conveniently be arranged by classifying cases under the following headings:

(1) **Crisis.** (a) *Simple adrenal insufficiency*:—Cases of Addison's disease presenting typical signs of crisis, namely: great weakness or coma, feeble pulse of small volume, markedly low blood pressure with systolic readings as little as 50 mm. Hg., haemoconcentration, elevated non-protein nitrogen and low serum sodium, must be treated with utmost alacrity. Time should not be taken for any prolonged analysis, but a sample of blood may be obtained for subsequent investigation just before starting intravenous therapy. The thing of immediate importance is to replenish the reduced circulating amount of fluid and for this normal saline is satisfactory. Since the patients are suffering from severe depletion of their sodium stores, it is better to administer a hypertonic solution if this is available. Glucose, too, is important, furnishing ready fuel and, in cases in which hypoglycaemia is a marked feature, it is imperative. An intravenous solution of the following composition is satisfactory: normal saline 700 c.c., 5 per cent. saline 900 c.c., 50 per cent. glucose 400 c.c. The first half litre of this fluid should be run in fairly rapidly in the course of one-half hour or less; after that it should be given more slowly so that the patient gets another 1,000 to 1,500 c.c. in the next twelve hours. Not more than 2,000 c.c. should be given by the intravenous route in twelve hours and at the end of that time, as the patient is usually taking fluid by mouth, the intravenous injections may be safely discontinued.

Adrenal cortical extract is a beneficial adjunct to the above therapy and, if available, should be given at the outset, 15 to 20 c.c. being run in with the saline in the first fifteen minutes. Thereafter 5 c.c. may be given periodically at the end of the first, third and eighth hours.

If for any reason intravenous therapy is not immediately available, and the patient obviously *in extremis*, 15 to 25 c.c. of the cortical extract should be administered intravenously over a period of five to ten minutes and repeated in 5 c.c. doses every few hours until the saline treatment can be instituted or until recovery is well on the way and fluids, salt and food can be taken by mouth. No signs of overdosage are known short of continued extract treatment with large amounts of extract for a week or more and, then, these are not dangerous, being merely rapid weight increase and perhaps headache.

Following the first twenty-four hours' active treatment, the patient has usually improved markedly and may even feel strong enough to get up. This should, of course, be forbidden till he is once more taking a normal amount of food and adequate salt. 10 to 20 c.c. of extract is usually adequate on the second day, and half of this on the third. By the end of the week the patient may be strong enough to be up and the extract may then be discontinued.

(b) *Infection.* This constitutes a most serious hazard. It may occur as an accompaniment of the disease when tuberculosis, which is a common cause of the adrenal deficiency, affects some other system such as the respiratory. The two processes must then be treated individually. When, as often happens in otherwise uncomplicated cases, upper respiratory infection, or pyelitis in females, occurs, marked exacerbation of the symptoms of Addison's disease is seen, loss of strength and fall in blood pressure being marked, the fever and

*The cost for a patient receiving an average maintenance of 5 c.c. every other day would be about $2.00 a week.

toxicity generally appear to be out of all proportion to the objective signs of actual infection, and there may be no perceptible changes in the blood chemistry. Under these circumstances, extract is the most important form of treatment and large amounts should be administered from the outset and intramuscular injections of 5 c.c. into the buttocks given every few hours thereafter. Only if the patient is dehydrated at the start or fails to take adequate fluid by mouth should intravenous normal saline and glucose be given and, then, in moderate amounts only. In spite of such procedures, the patient may die with the appearance of profound toxaemia and hyperpyrexia.

2. **Remission.** Many cases obtain a great restitution of energy and sense of well-being by the mere consumption of extra salt, as already stated. Their disease is probably less acute and less far advanced when recognized. Eight grams of sodium chloride and four of the citrate salt is not an unusual amount to be tolerated with benefit. Less may suffice but trial alone will show.

3. **Chronic Adrenal Insufficiency.** (a) *Simple*:—There are cases which either cannot tolerate the amount of added salt necessary to maintain blood values near normal, and thus confer the resultant benefits of increased strength, or which, in spite of ingestion of large amounts of salt, develop frequent crisis. These must receive extract and as little as 5 c.c. of the preparation previously referred to, given intramuscularly on alternate days, results in restoration and maintenance of more normal blood pressure and chemistry and greatly increased appetite and strength. The salt intake need only be one-third to one-half that previously attempted.

(b) *Hypoglycaemic*:—A few patients show periodic attacks of hypoglycaemia, more or less severe, even when apparently taking and tolerating salt well. Cortical extract on alternate days remedies this shortcoming.

In conclusion, it should be emphasized that sodium salts constitute the keel of modern therapy in Addison's disease. Adrenal cortical extract is of great emergency value and is a useful rudder when salt fails to keep the vessel on its appointed course.

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CASE REPORT.

By B. F. HAZLEWOOD, M.D.

The following is the case report of a patient in whom the provisional diagnosis immediately following admission was cranio-cerebral injury, with possibly an extra-dural hematoma. The purpose in presenting this case is to emphasize the occurrence of serious injuries to the cervical spine and cord complicating relatively minor cranio-cerebral injuries. The possibility of Horner's Syndrome resulting from lesions within the spinal cord and brain stem is emphasized and the mechanism of production discussed.

Case Report.

H.C., a mentally disturbed male, aged 23, was admitted to the surgical wards of the Toronto General Hospital on August 14th, 1936.

For approximately two years prior to admission, patient had been an inmate of an Ontario Hospital. He was discharged in the early part of 1936. The night of August 13th, 1936, he jumped from a second-storey window, was found by his

family in a semi-conscious state and carried to bed. Within an hour, he was seen by his physician, who admitted the patient to the local hospital. A scalp wound some three inches in length, situated in the right parietal region, was sutured. He became fully conscious and was quite bright. General examination showed no disturbances of motor or sensory function — he moved both arms and both legs and no abnormality of reflexes was noted.

Eighteen hours after the accident, the right pupil was observed to be dilated, and for the first time a flaccid paralysis of the left arm and leg became obvious.

On admission to the Toronto General Hospital, 24 hours after the accident, the patient was unco-operative and indifferent to his surroundings and no history was obtainable from the patient. Examination revealed the following findings: A lacerated contusion over the right parietal region; the left upper lid drooped and the right pupil was 7-8 mms. in diameter, compared to 3-4 mms. for the left pupil. Both reacted to light, direct and consensual, although contraction of the left was sluggish. The temperature of both sides of the face was equal, movements of the cervical spine were full in all directions and no tenderness was elicited on pressure over the spines of the cervical vertebrae.

Movements of the left arm were restricted to those brought about by the contractions of the deltoid, biceps and brachialis, all muscles obtaining their principal nerve supply from the fifth cervical segment. There was no movement of the left leg. Both the paralyzed arm and leg were flaccid. Power and tone were normal throughout the right arm and leg.

The tendon reflexes, normal on the right side, showed sluggish biceps and radioperiosteal jerks in the left arm and absent knee jerk and ankle jerk. Abdominal reflexes were not elicited on either side. Plantar stimulation produced a flexor response on the right and no response on the left.

Examination of sensation was extremely difficult due to the patient's mental confusion. It became evident that there was complete loss of sensation of pain and temperature below "C4-T4" on the right half of the trunk and below C5 over the right arm. Light touch, vibration sense, joint sense, and two point discrimination could not be satisfactorily examined.

There was no disturbance of cranial nerves and no blood or cerebro-spinal fluid loss from nose, ears or pharynx.

Temperature, 99.2; pulse, 80; respirations, 18; W.B.C., 16,000; urinalysis, negative.

Lumbar puncture: pressure, 175 mms. Jugular compression showed that there was no block in the sub-arachnoid space. Cerebro-spinal fluid was pinkish-yellow in colour, suggesting an intimate admixture of a small amount of blood.

X-rays of the skull revealed no abnormality. Stereo antero-posterior and lateral plates of the cervical spine showed a compression fracture of the fifth cervical body; a very slight amount of shortening was present, but there was no gross deformity.

The day following admission, the left pupil was noted to be still smaller and the ptosis more marked. The left side of the face was warmer than the right side and perfectly dry. These signs constituted a typical Horner's Syndrone.

During the twelve days he was under observation, he became progressively more disorientated and irrational and was finally discharged to the Ontario Hospital at Whitby. Prior to discharge, he showed spasticity of the left arm and leg. The tendon reflexes were hyperactive and a Babinski reflex was present.

Provisional Diagnosis. — (1) Cranio-cerebral injury; (2) Contusion and probable laceration of the left lateral column of the spinal cord at the level of the sixth typical Horner's Syndrome.

The cranio-cerebral injury apparently was of relatively little significance. At the time of writing, the patient is still in the Ontario Hospital and shows marked improvement in his psychiatric condition. However, he suffers from a severe left-sided spastic hemiplegia below C5-6. Pain and temperature are not recognized below C5 over the right side of the body. Joint sense, vibration sense and two point discrimination are everywhere normal. Light touch is everywhere recognized. No evidence suggests serious damage to the soft parts of the neck.

Of particular interest is the mechanism which resulted in marked inequality of the pupils. At first sight, the combination of trauma to the right side of the head, the "dilated" right pupil and the paralysis of the left side, suggested a sub-dural or extra-dural hematoma over the right cerebray hemisphere, rather than Horner's syndrome.

The symptom complex, known as Horner's syndrome, was first described by J. F. Horner, Professor of Ophthalmology at Zurich in 1869. He described a case in which "the pupil on one side is constricted; the globe sunken inward and less firm than the other; the face on the affected side is red, warmer and perfectly dry, the line of demarcation being in the mid-line." The myosis he attributed to paralysis of the pupillary dilator fibres from the sympathetic; the

ptosis due to weakness of the levator palpebrae superioris muscle, also supplied by the sympathetic. Loss of sweating he attributed to paralysis of the cervical sympathetic fibres, which supply the sweat glands. We know that the warm red skin is also due to sympathetic paralysis.

Bernard in 1858 had recognized all the now well-known sequelae of sectioning the cervical sympathetic and described their occurrence in cats and dogs in a paper published in that year. He gives no indication in his work of having observed human beings suffering from paralysis of the cervical sympathetic.

The accumulated observations of many examples of Horner's syndrome in experimental animals and in man have failed to add any significant findings to Horner's and Bernard's original descriptions. Verified lesions of the lateral portion of the pons, damage to the medulla oblongata, and lesions of the cervical cord all may produce Horner's syndrome in man.

Beattie, Brow and Long confirmed the observations of Karplus and Kriedl that stimulation of the hypothalamus can produce pupillo-dilatation. Further, these authors showed that the pupillo-dilator pathway was uncrossed and that stimulation of a small circumscribed area in the hypothalamus could produce such a dilatation. This experimental work bears out the clinical observation that lesions in the brain stem and cervical cord may cause Horner's syndrome. Destruction of the ventral roots of first and second thoracic (and possibly eighth cervical) or the fibres of the cervical sympathetic trunk also results in "Horner's syndrome."

In summary, we have presented a case in which a relatively minor craniocerebral injury tended to obscure a serious lesion of the spinal cord. This latter was situated in the lateral column of the left side of the cervical cord. The upper level of the lesion extended to the sixth cervical segment.

Notanda. — The writer wishes to acknowledge the courtesy of Dr. K. G. McKenzie and the Department of Surgery for making available the records of the patient, and to thank Dr. Harry Botterell for his help in studying this case.

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"Stone walls do not a prison make, Nor iron bars a cage."

Winter is a jailer who shuts us all in from the fullest vitamin D value of sunlight. The baby becomes virtually a prisoner, in several senses: First of all, meteorologic observations prove that winter sunshine in most sections of the country averages 10 to 50 per cent. less than summer sunshine. Secondly, the quality of the available sunshine is inferior, due to the shorter distance of the sun from the earth, altering the angle of the sun's rays. Again, the hour of the day has an important bearing: At 8.30 a.m., there is an average loss of over 31 per cent., and at 3.30 p.m., over 21 per cent.

Furthermore, at this season, the mother is likely to bundle her baby to keep it warm, shutting out the sun from Baby's skin; and in turning the carriage from the wind, she may also turn the child's face away from the sun.

Moreover, as Dr. Alfred F. Hess has pointed out, "it has never been determined whether the skin of individuals varies in its content of ergosterol" (synthesized by the sun's rays into vitamin D) "or, again, whether this factor is equally distributed throughout the surface of the body."

While neither Mead's Oleum Percomorphum, nor Mead's Cod Liver Oil Fortified With Percomorph Liver Oil, constitutes a substitute for sunshine, they do offer an effective, controllable supplement, especially important because the only natural foodstuff that contains appreciable quantities of vitamin D is egg-yolk. Unlike winter sunshine, the vitamin D value of Mead's antiricketic products does not vary from day to day or from hour to hour.

BONE TUMOURS—Part I.*

By W. L. M. KING, '37.

In this article will be discussed the normal development of bone and the common benign tumours of bone, with the exception of the giant-celled tumour.

Histogenesis of Bone.

This discussion is taken from the work of Dr. Ham of the Dept. of Histology, whose conception of bone formation is, to me, the clearest and most logical of the modern views on the subject.

The two types of bone—membrane or dermal and cartilage bone—each originate from the embryonal mesenchyme. Their difference in structure lies in the difference between their developmental environments.

Membrane Bone arises in an area of multipotential mesenchymal cells, which, from the first, contains an excellent blood supply. The first evidence of bone formation in this area is the accumulation in these cells of a bluish-staining cytoplasm. As they differentiate, these cells become more rounded and are known as osteoblasts. They begin to secrete a matrix, forming lacunae about themselves. Growth at first depends on differentiation of more mesenchymal cells into osteoblasts, but the latter soon become used up, and, in order for growth to continue, the osteoblasts develop the ability to divide into two cells, one of which goes on to maturity as an adult bone cell, but the other of which retains its osteoblastic properties and ability to reproduce. The latter take up a position close to the bone, outside and inside, and constitute the periosteum, being known as osteogenic cells. From these are formed the cells which maintain growth throughout life.

Cartilage Bone develops in an area of mesenchyme, which is relatively avascular. Cartilage does not turn into bone, but is replaced by it. In the area that is to become bone, the mesenchymal cells develop about them a primitive matrix, which soon becomes demarcated from the surrounding mesenchyme in the shape of the bone-to-be. The matrix intensifies and lacunae form around the cells, the result being cartilage. This becomes surrounded by a layer of cells capable of forming cartilage and called the perichondrium. The mass increases in size by appositional growth at the periphery and interstitial proliferation of the mature cartilage cells in their lucanae.

Now, blood vessels begin to appear in the perichondrium, the cells of which, under the stimulus of this new environment, begin to differentiate into osteoblasts and lay down a bony matrix. This spreads around the entire shaft, forming a shell of bone. The old cartilage shaft begins to break down, starting at its centre, and a tuft of osteoblasts and young blood vessels pushes its way in from all sides at the centre of the shaft, replacing the cartilage. This is a called the *periosteal bud*. These young blood vessels and osteogenic cells exert a melting effect on the old cartilage as they come in contact with it. Adult bone cells form and start to consolidate the centre, first by trabeculae, and later by compact bone. This young tissue extends up and down the shaft, the cartilage receding before it, until the whole shaft is replaced by bone. The same process the bone, forming the epiphyses. The goes on independently in the ends of bone grows in length because the epiphyseal plate keeps receding from the centre of the shaft without becoming ossified until the growth stimulus has ceased. Growth in breadth of the bone is appositional from the periosteum. There is no interstitial growth possible now. When growth ceases, the car-

*The first of a series of six.

tilage of the epiphyseal plate becomes replaced by bone, that of the articular cartilage alone remaining unossified throughout life.

Bone Resorption. — Dr. Ham believes that the large giant cells, called osteoclasts, which one find associated with bone resorption during growth and following fracture, are foreign-body giant cells formed by the osteogenic cells, as a response to irritation produced by the dead cartilage and old bone. That they, like all cells of the body, can secrete CO_2 and this plays a minor part in eroding the dead bone and cartilage, he does not deny. But they are essentially the *result* of the absorptive process and not the cause of it. Recent work indicates that deposition of calcium salts into matrix is a physico-chemical process and that the calcium simply precipitates into the matrix from the tissue fluids. According to the laws of solubility, it is reasonable to suppose that the tissue fluid, which is closely in contact with the bone, can redissolve it when its chemical nature is suitably changed.

Further, it is probable that the new bone matrix is not very different from that of the old cartilage and the small amount of remaining cartilage matrix becomes incorporated into the bone matrix. This, together with the peculiar melting effect that the new bone matrix seems to have on the old, serves for the present as a plausible explanation of bone resorption.

Benign Tumours of Bone.

I. **Osteochondroma** (simple Osteoma, Benign Exostosis). This is the largest group of benign tumours arising from the precartilaginous connective tissues of the skeleton. There are two main types:

A.—Compact or Ivory Osteomata occurs on the outer and inner tables of the skull. The former are not significant. The latter, growing in, produce cerebral compression, with epilepsy or Jacksonian seizures. If arising in the external auditory meatus, vertigo and deafness result.

B.—Cancellous Osteomata are derived from cartilage and grows chiefly at the articular ends of long bones. They are frequently traumatic in origin, the blow producing a displacement of cells, which take on abnormal growth. They are also common after rickets.

The age incidence is 10-25 years. They usually appear before or at puberty. The majority are symptomless, being evident merely as painless swellings of the bone, with or without stiffness or rheumatic pains in the neighboring joint. The average duration of symptoms is five years. The diagnostic features are a base or pedicle of normal bone protruding through a periosteal gap, and a neoplastic cartilaginous cap on the tumour. X-ray shows an osseous outgrowth, with cancellous and compact portions, merging with normal bone beneath, and capped with cartilage in varying degrees of calcification. These tumours are thought to be exaggerations of a normal bony protuberance, where an important tendon is anchored, the tumour being formed by cartilaginous ossification within the tendon substance.

An acute exacerbation of symptoms or sudden increase in rate of growth of the tumour indicates a malignant change. This is to be feared in untreated cases after the age of 30, and thus repeated X-ray examination is advisable in these cases. Treatment is to leave these exostoses alone, if not producing symptoms, and, if so, to excise thoroughly, thus preventing recurrence.

Sub-ungual exostoses are a variety of this tumour occurring under the nails of hands and feet. These are extraordinarily painful and must be removed by excision. They differ from ordinary exostoses, in that they form adhesions with surrounding tissues.

The osteochondromata may have to be differentiated from ecchondroses at articular margin, due to osteoarthritis or Charcot's disease, from excessive callus around a fracture following chronic suppuration or tabes dorsalis, from leontiasis ossium, from ossifying

chrondromata and sarcomata, and from myositis ossificans.

II. **Chondromata** (Chrondromyxomata).—They are usually centrally located in the skeleton, benign tumour occurring in the short bone of hands and feet, spine, ribs and sternum. The age incidence is 20-30 years. These tumours occur during the growing period only and cease when that is over. They arise from supernumary joint cartilages, derived from prechondral connective tissue, which normally forms joints in the body. They start as aberrant strands of connective tissue, which traverse the axis of the future bone at right angles. As development progresses, they become enclosed, proliferate, and gradually give rise to central chondromata. These tumours may reach a huge size. The surface is lobulated and the tumour well encapsulated. They have a curious tendency to invade veins, even when not malignant. Myxomatous degeneration is frequent, resulting in the formation of cyst-like cavities, containing a glairy, mucinous material. Ossification is frequent when the tumour has ceased growing.

These tumours are rarely multiple and rarely involve the long bones. Symptoms are mild and extend over five years or so. Recurring soreness and a slowly increasing swelling are the only effects. They are prone to undergo sarcomatous degeneration and their presence, on that account, is ominous, especially in the ribs and sternum. Treatment is thorough and complete excision, to prevent recurrence. The X-ray appearance is that of a large cystic cavity, surrounded by a shell of bone. Differentiation may have to be made from periosteal sarcoma, callus formation around a fracture, myeloma, tuberculous dactylitis of the hand, and multiple secondary sarcomata.

III. **Multiple Cartilaginous Exostoses** (Diaphyseal Aclasia; Hereditary Deforming Chondrodysplasia).—This is a congenital disturbance of the perichondrium and, therefore, affects the cartilage bones. Disturbances and deficiencies in the periosteum lead to widening of the metaphysis and inhibition of bone growth. There are also multiple osteochondromata projecting out and centrally from the disphyses of the long bones.

The disease is three times more common in males and the patients are young. The long and short bones are involved; skull and face escape. The two chief pathological changes are: (1) *growth and retardation*, resulting in stunted stature, pes valgus, and other deformities due to unequal growth in length of the bones and cyst formation (as seen by X-ray), and (2) *proliferative changes*, producing enlargement and distortion of the epiphyses with bony outgrowth confined chiefly to the acromion and the head of the fibula. Stalactite-like growths, capped with cartilage project out from the ends of the diaphyses. These growths are commonly post-traumatic. The disease stops when growth is over.

The patient comes to the surgeon about puberty, complaining of pes valgus, pressure symptoms, or general bone pains. Prognosis is good for life, but there is no treatment except surgical relief of deformities or pressure symptoms after the growth period has terminated. Malignant change is rare.

BONE TUMOURS—Part II.*

BENIGN GIANT CELL TUMOUR OF BONE.

By ROSS CAMPBELL, '37.

The benignancy of this lesion was recognized as early as 1860 by Nélaton, but many contemporary clinicians and pathologists, are still pre-Nélaton in their views. Proof of this lies in the multitude of names attached to the tumour. It is known variously as:

Tumeur à Myeloplaxes (Nélaton).
Mydoid Sarcoma, Myeloma (British).
Giant Cell Sarcoma, Giant Cell Sarcoid, Benign Giant Cell Sarcoma of Epulis Type (Ewing).
Osteitis Fibrosa Cystica.
Haemorrhagic Osteomyelitis, and
Giant Cell Tumour.

Admittedly, there are occasions when the diagnosis is not clear-cut, but careful investigation will lead to a correct diagnosis in the majority of cases. Treatment is then comparatively simple and cure is complete, whereas when it is misdiagnosed as sarcoma, needless mutilation and disability result from the radical treatment employed.

Etiology.

Some confusion exists as to whether this condition is a true blastoma or, as more recently suggested, the result of an inflammatory process, which takes on features of neoplasm.

Mallory, Codman and Barrie support the latter theory, believing that the giant cells are a natural reaction of large enothelial leukocytes to the absorption of calcium salts, a normal phase of repair following intra-osseous haemorrhage, due to rupture of nutrient vessels to the bone.

Konjetzny showed that intramedullary haemorrhage stimulates bone marrow to a reactive proliferative process, in which all the elements of G.C. (giant cell) Tumour can be found.

These men stress:

1. Absence of pleomorphism, hyperchromatism or excess mitoses in tissue cells.
2. Fibrous stroma, poor in cells.
3. Uniformity of G.C. nuclei.
4. Relation of G.C.'s to extravasation, indicating resorptive rôle.
5. Constant presence of old blood pigment in tumours.

as evidence against the blastoma theory.

Going further, we find that Geschickter and Copeland turn back to the Histogenesis of Intracartilaginous Ossification (see Part I. in this issue) for their explanation, not only of Benign Giant Cell Tumour (Benign G.C.T. henceforth, but of Bone Cysts or Osteitis Fibrosa Cystica, which they consider to be different phases of the same process.

When cartilage resorption is at its height, the picture is a veritable G.C.T., the cavity of the bone being filled with giant cells, round cells, small vessels, haemorrhage and osteoblasts, the latter collecting at the periphery, where they aid in the formation of new bone.

Geschickter and Copeland also point out that in children and young adults, the areas of new bone formation are the epiphysis and metaphysis, which points likewise are the site of Benign G.C.T. They would label the process progressive osteoclasia as opposed to regressive osteoclasia, as in bone cyst. The occurrence of G.C.T.'s in the skull (but not in membrane bone) and in tendons in relation to sesamoid bones, follows the distribution of the cartilaginous centres of ossification, supporting the view that these tumours are related to the normal process of ossification.

*The second of a series of six.

Evidence in favour of trauma as a cause of tumour is not positive, but strongly suggestive. There is frequently a history of antecedent trauma, particularly in the region of the epiphyses (usually the most exposed parts of bone), where the blood supply is to a large extent subperiosteal, and thus easily disrupted. G.C.T.'s and early Bone Cyst are symmetrical and subcortical in location and occur in the epiphyses.

Trauma disrupts the cortical blood supply, producing an imbalance between osteoclastic proliferation engaged in cartilage resorption and the normal reactive compact bone in the cortex. In the young person, this results in bone cyst in the metaphysis, where the cortex is thicker and more reactive. In the young adult, it results in G.C.T. in the epiphysis.

There are probably additional metabolic factors, such as parathyroid disturbances, but the work is not conclusive as yet.

Clinical Features.

Records at the Registry of Bone Sarcoma give the following figures:

Ratio of malignant bone sarcoma to Benign G.C.T.=2:1.

Commonest age group is from 16-25 years, with one case at six years and one at 68.

The sexes are affected about equally, the ratio of females : males being about 6:5.

The common sites of involvement are:

1. Lower extremity=56% all cases. Lower end of femur; upper end of tibia—involved in 47% of all cases.
2. Upper extremity=23% all cases. 40% of these in lower end of radius.
3. Bones of trunk—pelvis, jaws, etc.=21% all cases. The jaw is rarely affected after age of 25.

The average duration of tumour symptoms is 14 months in femur and tibia, and 20 months in the radius.

This condition occurs principally at the ends of the long bones in the metaphysis or epiphysis. It grows slowly and is of long duration.

Pain is a frequent and early symptom. It persists after radiation therapy, unlike the pain of osteogenic sarcoma.

Complete pathological fracture is often the first sign. It occurs in 14% of all cases.

Frequently a history of trauma to the limb some months before, is obtained.

The general condition of the patient is usually good, unless sepsis has set in.

If the tumour is in a vertebral body, signs of compression may be present.

If the tumour is large, the skin over it may resemble pig-skin, be oedematous and cyanotic. Ulceration is rare.

When the lesion, which is generally single and asymmetrical, is palpated, a spheroidal enlargement can be made out. This has a thin bony capsule, which, on pressure, exhibits egg-shell crackling. In very vascular tumours, there may be slight pulsation and a bruit.

Joint involvement is rare, articular cartilage being apparently very resistant, although there may be, at times, a slight thickening of the capsule with clear effusion into the joint cavity.

Attempts at spontaneous healing are sometimes made, resulting in fibrosis, some ossification and cyst formation in the centre, but if left untreated, some of these cases develop fatal haemorrhage and sepsis.

Roentgenologic Diagnosis.

A good X-ray picture is characteristic. It shows a bulky spherical shadow with a thin bony capsule. This capsule is continuous with normal cortex and periosteum adjacent to the tumour. The centre of the tumour mass shows a characteristic "soap bubble" appearance, caused by thin or wide bony trabecular running from one side of the bony capsule to the other.

Occasionally the bony shell may show a break in continuity or indeed be wholly absent at times, suggesting osteogenic sarcoma. However, the normal cortex and periosteum adjacent to the tumour, the involvement epiphysis, non-continuation of shaft into tumour and apposition to articular cartillage, suggest Benign G.C.T.

Pathology.

Gross.—The tumour is medullary in origin, growing from within outwards, destroying bone, but growing slowly enough to allow the surrounding periosteum to lay down a bony shell.

The appearance of tumour tissue in the gross depends on the phase of the lesion. Typically, one finds a haemorrhagic, friable solid tissue and numerous small cysts with irregular bony or fibrous trabeculae. The whole mass is vascular, soft and oozing, resembling red currant jelly. It is usually more firm and fibrous at the periphery, where the reaction resembles the fibro-ostosis of bone cyst. Spread occurs rapidly through the cancellous bone, which appears to be less resistant than the cortical bone. The cortex lays down both fibrous tissue and new bone.

The capsule usually does not break down until quite late and the growth shows little tendency to invade the soft parts.

Microscopic.—Essentially, the tumour consist of giant cells and loose cellular stroma containing round cells, spindle cells and blood spaces.

The giant cells are typical osteoclasts with acidophilic, opaque cytoplasm and regular, separate nuclei, 15-20 in number, grouped in the central part of the cells as distinct from tumour giant cells and foreign body giant cells.

The spindle cells are inversely proportional to the giant cells, while the round cells are directly proportional. Ewing thinks that an excess of spindle cells indicates malignancy, but Goeschickter denies this, claiming they are fibroblasts, essentially similar to those seen in osteitis fibrosa.

Haemorrhage, with red cells and old blood pigment scattered throughout the tumour, and newly-formed vessels are conspicuous features. Areas of organizing haemorrhage, similar to granulation tissue, are often seen.

Small spicules of old bone with osteoclasts attached, or new bone with osteoblasts on the surface, may be present.

Old tumours show marked differentiation of fibroblastic stroma entering the cicatrizing and fibrosing stage, evidence of attempts at healing.

At this point, it might be well to mention a few variants:

1. Myxomatous G.C.T. — periphery shows slightly smaller spindle cells imbedded in mucinous matrix.
2. Giant Cell Epulis of alveolar border — two types: giant cell and fibroid, occurring between ages of 6-45 years. Rare at site of molar teeth, corresponding mostly to location of deciduous teeth. They resemble G.C.T. pathologically. Prone to recur unless excision has been thorough.
3. G.C.T. of Tendon Sheath—occur in relation to sesamoid bones, which develop in cartilage between ages 25-40. Size varies from pea to egg. They are yellow in colour due to old blood pigment and lipoid. Microscopically, fibrous tissue, remains of white cartilage, foam cells and old haemorrhage predominate. Complete excision suffices to cure.
4. G.C.T. of soft parts mostly related to aberrant sesamoid bones.

Malignancy.

In the vast majority of cases, this tumour is benign. It is significant that in no case has a secondary nodule of typical G.C.T. been found in lung and in no case has the association of a benign and typical G.C.T. in bone with

secondary metastatic osteogenic sarcoma in lung been proven.

Secondary infection after curettage leads to errors in the microscopic picture. often suggestive of malignancy

Whether or not recurrences after improper treatment undergo malignant change has never been settled.

Diagnosis.

The correct diagnosis can, in most cases, be arrived at after a careful study of history, physical findings and X-ray, supplemented by biopsy.

Differential Diagnosis.

1. Tuberculous Osteomyelitis and Tuberculous Joints.—Here the swelling is symmetrical and there is fusiform swelling of the joint. The tuberculin test is of doubtful value.

2. Pott's Disease. — The earlier appearance, pressure signs, intermittent pain, absence of abscess and non-destruction of articular discs point to tumour.

3. Osteogenic Sarcoma. — In this, there is no invasion of the epiphysis, the swelling is fusiform and the cartilage of the joint is involved.

Moreover, this lesion occurs in a younger age group and the location is different. The pain is more severe in this condition. In the X-ray, the adjacent cortex and periosteum show reaction and there is early perforation of the bony capsule, with invasion of soft parts.

4. Osteitis Fibrosa.—Shows less expansion of shaft, lesion mostly in shaft, gradual instead of abrupt thinning of cortex and occurs mostly in older age groups.

Therapy.

1. Amputation. — Too radical in most cases.

2. Resection.—Ofter useful.

3. Curettage.—Most Popular.

Consists in going in and thoroughly removing all the tumour tissue, after which the cavity is swabbed with pure phenol, then neutralized by alcohol. Care is taken to avoid infection, as the tumour tissue and bone marrow are especially susceptible. Improper curettage results quite often in recurrence, with the necessity of repeating operation, increasing the danger of infection and possibly of tendency to malignancy.

Amputation may be necessary where repeated curettage fails, the tumour is very large, or in cases where the joint is involved.

4. Radiation, especially with large doses of X-rays, shows a marked effect on the tumours, particularly when they are superficial and in young patients. Two phases are noted—the negative, in which the lesion gets larger, more vascular and more painful, lasting two to four months, and the positive phase, in which there is shrinkage of the tumour and diminished or absent pain plus a laying down of fibrous and bony tissue, which never, as a rule, completely fills in the space. Small cysts filled with old blood or fluid remain. This method has been used with good results at Memorial Hospital, and it may be wise to use it in early cases. It is especially useful in tumours of spine.

Prognosis.

1. Occasional spontaneous cure.

2. If left alone, there are two courses:

   (a) Advanced growth may lead to fatal haemorrhage and septicaemia.

   (b) Partial repair by firm fibrous tissue may occur, with thickening of the bony shell, but persistence of central cysts.

3. If complete curettage or adequate radiation therapy is applied, complete cure occurs in all but 20% of cases (Geschickter). These show recurrence, even after complete curettage.

Thanks are respectfully due to Dr. Don. Moore, of the Department of Pathology, for valuable criticism.

GOITRE.

D. H. McKAY, '37.

It is my intention to present, in as clear and concise a form as possible, a resume of the condition known as goitre.

Physiology.

Thyroxine, the active principal of the thyroid gland, facilitates and catalyses the oxidative activities of the body and thus regulates the general level of metabolism. As well, it appears to sensitize the whole, or part, of the endocrine glands. A consideration of the function of the thyroid gland enables one to interpret many of the clinical manifestations of hyperthyroidism.

Etiology and Pathology.

The etiology of hyperthyroidism is still obscure. Iodine deficiency by itself is not the essential cause of goitre, but there must be, in addition, a positive goitrogenic factor. In hyperthyroidism, there is a generalized hyperplasia of the gland substance. Should a large portion of the thyroid gland of a dog be removed, the remainder becomes wildly hyperplastic. It is also known that a deficiency of iodine will likewise stimulate the gland to hyperplasia. These, no doubt, are examples of compensatory hyperplasia, the remaining portion of gland having been speeded up to meet the requirements of the body.

Often during periods of stress and strain, notably puberty, pregnancy and lactation, the thyroid gland becomes slightly enlarged. The supply of thyroxine has not been adequate to meet the demand. This again is presumably a compensatory hyperplasia.

Bacterial infection may play a part. The toxins produced possibly stimulating the thyroid gland to hyperplasia, or else the body might utilize the iodine supply in its fight against the invading organism, thereby producing a hyperplastic gland, due to iodine insufficiency. It is possible that vitamin deficiency has a role to play as a causal agent.

Hyperplasia and Involution.

In order to understand fully the pathology in a clinical course of hyperthyroidism, it is important that one has a clear conception of hyperthyroidism, it is important that one has a clear conception of the processes of hyperplasia and involution.

1. *Goitre—Diffuse Hyperplastic.*

Gross.

(1) Diffuse enlargement.
(2) Highly vascular.
(3) Raw-beef appearance.
(4) Cut surface coarse and finely granular. No colloid.
(5) Soft elastic glandlike feel.
(6) Devoid of areas of increased density.

Microscopic.

(1) Fibrous stroma divides gland into lobules.
(2) Predominance of parenchyma.
(3) Colloid in acini much diminished thinned, vaculated, retracted from acinar wall and at times absent.
(4) Epithelium columnar in type, sometimes densely packed together, forming small round acini or often growing in lace-like fingers, forming papillomatous infoldings. Either or both types of epithelio hyperplasia may be present.

It must be remembered that owing to the clinical use of iodine prior to operation, this picture is seldom seen, the gland having undergone involution.

2. *Goitre—Diffuse with Involution.*

This picture is sen following the administration of iodine in the treatment of diffuse hyperplastic goitre. It is also seen in the so-called colloid goitre

brought about by spontaneous involution. Both represent the same process, but present slightly different pathological pictures, so I shall discuss them separaately.

(a) *Diffuse hyperplastic goitre following the administration of iodine.*

Gross.

(1) The elasticity is lost and the gland has become firm and brittle.
(2) The vascularity has decreased.
(3) The cut section appears glary and amber coloured.

Microscopic.

(1) Increase in connective tissue.
(2) Colloid increased in density and amount.
(3) Acini regular in size and shape.
(4) Epithelium has returned to the cuboidal type.
(5) The lmphocytic infiltration has decreased.
(6) There may remain a few scattered areas of epithelial hyperplasia.

(b) *Colloid Goitre.*

This gland was at one time mildly hyperplastic and has undergone involution with various degrees of hyperinvolution.

Gross.

(1) Diffuse enlargement.
(2) Soft in consistency.
(3) Cut surface amber in color and finely honeycombed in appearance.
(4) Very often cystic cavities are visible to the naked eye.
(5) Haemorrhage is commonly present.

Microscopic.

(1) A great deal of normal-looking thyroid tissue.
(2) Various degrees of acinar enlargement.

Some acini are slightly enlarged showing a minor degree of hyperinvolution, the epithelium being flattened and beadlike, the acini filled with deeply staining colloid material. Very often thin walls have ruptured to produce colloid adenomas. At times a degenerative process has resulted in formation of larger cystic cavities. Surrounding these areas is compressed normal gland.

(3) Occasionally areas of hyperplasia may be present.
(4) Collections of lymphocytes may be found.
(5) Haemorrhage areas are occasionally seen.

The term Colloid Goitre should be reserved for diffuse hyperinvolution rather than the cystic types which fall more into the class of Nodular Goitre.

3. *Goitre—Nodular.*

An adenoma of the thyroid gland is a localized encapsulated structure which may be of two types. The Colloid adenoma and the so-called Foetal adenoma. It should be stressed that these are not adenomas in the true sense of the word but rather the end results of hyperinvolution and hypoinvolution.

(a) Colloid Adenoma.

The Colloid adenoma is the result of hyperinvolution and is similar to the Colloid goitre except that it is localized encapsulated area. Cystic formation is common owing to coalescence of the adjacent acini due to the breaking down of the intervening walls.

Gross.

Localized circular nodules surrounded by a capsule of compressed thyroid tissue are distinctly marked. The nodules may be single or multiple and on cut section the honeycombed appearance and cystic cavities are easily seen. Haemorrhage into these cystic spaces is a common accompaniment.

Microscopic.

(1) Colloid filled acini of varying sizes.
(2) The epithelium is flattened and beadlike.
(3) Surrounding the nodule is compressed thyroid tissue.

(4) The remainder of the gland may or may not show areas of hyperplasia.

4. *Foetal Adenoma.*

These adenoma supposedly resulted from foetal cell rests. There may be a small group in which a true tumour may arise from these embryonic cells but it is more likely that they are hyperplastic areas which have resisted involution and have superimposed a degenerative process.

Gross.

In the gross they appear as gray, dense, elastic nodules, often flecked with yellow areas of necrosis. Haemorrhage is common and often followed by cystic formation.

Microscopic.

(1) The acini are widely separated by a hyaline structurless material often streaked with fibrosis.
(2) A few small fragmented acini are scattered through the nodule. Frequently only clusters of cells remain.
(3) The epithelium is of the cuboidal type with large, heavenly staining nuclei.
(4) Scattered large thin walled vessels are present.
(5) Haemorrhage is common.

Hyperplasia of the remaining thyroid tissue is a very common accompaniment of Nodular goitre. When such is the case the clinical symptoms are more likely due to this hyperplastic tissue rather than to the adenoma.

Clinical.

Classification.—A useful classification of goitre is the one at present used on Ward A of the Toronto General Hospital, which is primarily clinical but is very descriptive of the pathological condition as well.

This classification takes into account the group of cases with the clinical condition of hyperthyroidism but having a normal Basal Metabolic Rate.

The clinical picture of hyperthyroidism is varied but I propose only to list the chief signs and symptoms.

In considering the clinical symptoms and signs, one should view them in respect to the function of the gland, namely as an oxidizing catalyst, sensitizer of the autonomic nervous system and having a secondary effect on other of the endocrine glands.

History.

(1) Exopthalmos
(2) Goitre
(3) Tachycardia

Triad.

(4) Nervousness and irritability.
(5) Weakness and tiredness.
(6) Shortness of breath.
(7) Ravenous appetite.
(8) Flushing of face and neck.
(9) Heat intolerance.
10) Loss of Weight.
(11) Voice changes.
(12) Nausea or vomiting.
(13) Diarrhoea.

Examination.

1. General—Patient fidgety and restless.
2. Thyroid.
   (a) Enlarged

Diffuse.
Nodular.

Very frequently there is no enlargement.

Goitre
- *A. Diffuse*
  - *with Hyperthyroidism*
    - *with raised B.M.R.*
    - *with normal B.M.R.*
  - *without Hyperthyroidism (Colloid Goitre)*
- *B. Nodular*
  - *with Hyperthyroidism*
    - *with a raised B.M.R.*
    - *with a normal B.M.R.*
  - *without Hyperthyroidism*

(b) Bruit.
3. Lid lag.
4. Tremor of tongue.
5. Heart.
   (a) Enlarged—ham shaped.
   (b) Tumultuous beat.
   (c) Rate increase.
   (d) Blood Pressure—systolic raised—diastolic lowered.
6. Coarse or fine tremor of fingers.
7. Skin moist.
8. Reflexes hyperactive.
9. Raised B.M.R.

These represent the main symptoms and signs of hyperthyroidism. Many or all may be present, the latter being by far the exception.

Differential Diagnosis.

The diagnosis lies mainly between Effort Syndrome and Hyperthyroidism.

Effort Syndrome is a condition appearing in neurotic, asthenic people of sedentary habits who are below par physically and have no organic basis for their symptoms.

Breathlessness brought on by exercise is an invariable complaint. Palpitation is not infrequently present and dizziness accompanying changes of pisture or at the end of an effort is very common. Attacks of fainting of the vaso vagal type occur in a number of patients. They are often nervous and irritable and complaining of weakness, lassitude and fatigue. Praecordial discomfort is a very frequent symptom. This pain is not substernal but rises in the precordial region, often radiating to the left shoulder and may last a half hour or longer.

On mild exertion the heart rate jumps to 120-150 per minute and takes many minutes before returning to normal. The systolic blood pressure is slightly elevated and is easily influenced by exercise and emotional stress. Occasionally systolic murmurs are audible.

A careful history usually serves to distinguish this condition from hyperthyroidism. As a rule these neurotic individuals do not know when they were last perfectly well. This is in contrast to the true case of Primary Hyperthyroidism who cannot go six months from the onset of their symptoms without consulting a doctor. Often a valuable test is to have the patient elevate their leg to see how long they can hold it in such a position. A hyperthyroid patient makes a real effort and feels he can hold it much longer than he is actually capable of doing. The neurotic individual, on the other hand, underestimates his strength and soon drops his leg with the remark, "I can't, Doctor."

Treatment.

Pre-operative.

(1) *Rest.* Complete mental and physical rest is of the utmost importance. The patient should have a single room. All exciting literature should be banned and the patient not allowed to have visitors. To insure mental rest and to relieve apprehension, the course of treatment should be explained. It is wise to fully inform the patient regarding the Metabolism test which is often so very alarming. Luminal grs. 1 should be given at bedtime to promote sleep. If a patient is restless during the daytime this may be supplemented by luminal grs. ½ — three times daily.

(2) *Diet.* The hyperthyroid case should be on a simple diet of high caloric value. The fluid intake should be about 100 ounces daily. This can be provided by milk, cocoa, and glucosed drinks between meals.

(3) *Drugs.*
1. Lugol's Iodine min.X T.I.D. given in milk and grapefruit. This should never be given over long periods of time and especially when operation is contemplated.
2. For the first two days Digifolin min. XX - T.I.D. should be given and thereafter min. X daily.

These drugs produce a maximum effect in 10 to 14 days. The pulse rate and blood pressure drops and the patient becomes much less restless and perturbed.

(4) *Operative Preparation*—The day preceding the operation field is shaven and that night an enema is given. It is wise to give the patient an extra sedative to insure a good night's rest.
Premedication—An hour and a half prior to operation the following is given:
Morphia grs. ¼.
Atrophine grs. 1/150.
Hyoscine grs. 1/200.

Three-quarters of an hour prior to operation give:

If a woman { Morphia grs. 1/8. Hyoscine grs. 1/400.

If a man { Morphia grs. 1/6. Hyoscine grs. 1/400. Nembutal grs. 1½.

Post-Operative

1. A sedative enema is given following operation containing:
   Lugol's min. XL.
   Paraldhyde IV.
   Liq. Paraffin 111.
   This should be given as high as possible in order to be retained.
2. Intravenous of normal saline—3,000 c.c.'s in 24 hours.
3. Two ice caps.
4. Patient should be propped up in a Gatch frame.
5. A sedative such as Morphia grs. ¼.
   Atropine grs. 1/150 should be given if necessary. If the patient is not restless but unable to sleep—luminal grs. 1 may be sufficient.
6. Lugol's min. X should be given either by mouth or rectum Q. 3. H. X. 4.—Some prefer to administer it through the intravenous.
7. If troubled by mucus or difficulty in swallowing, a liquid paraffin spray will help. If still unrelieved one might resort to Tincture of Benzoin Co. drams one, sprayed through a Foley Inhalator. A steam tent is often very helpful in obstinate cases.

One should be constantly on the lookout for the danger signals of storms, notably a rising pulse, rising temperature and a restless patient. If the patient should lapse into storm the treatment is more concentrated.

(1) A sedative enema of
Chloral Hydrate grs. XX.
Pot. Bromide grs. LX.
Sod, Amytal grs. III.
Aqua ad IV.
should be given.
(2) Sodium Iodide (1-2 c.c.'s) given through the intravenous should be given every one or two hours for five or ten doses.
(3) To control the rising temperature an alcohol sheet or an ice water enema is effective.

Besides the physician must also watch for signs of respiratory difficulty and Parathyroid deficiency.

Convalescence.

A careful convalescence requiring three months is an essential. Following the operation the patient must be kept in bed for one month and then gradually allowed up with compulsory eighteen hours' rest daily for another month. Lugol's Iodine mins. X should be administered for six weeks following discharge from hospital. Before returning to work or active life it is necessary that the patient spend another month browsing about the garden or taking short walks, during which time he is entirely free of responsibility.

SOME SURGICAL INFLAMMATORY DISEASES OF THE KIDNEY

By GWEN S. HUDSON, B.A., '34.

Anatomy.

The kidneys lie internal to mid-Poupart line and extend from the transverse process of the twelfth dorsal to the third lumbar vertebra, the left being slightly higher than the right. The twelfth dorsal, ilio-inguinal and ilio-hypogastric nerves lie behind the kidney. The main structures entering the hilus of the kidney are, from before backward, vein, artery, ureter. The kidney is covered by a thin, glistening capsule. This is surrounded by the perinephric fat, which is thick along the borders of the kidney, in the sinus where it acts as packing for the vessels, and below the inferior pole of the kidney. Outside the perinephric fat is the renal fascia. This consists of anterior and posterior sheets. The former crosses in front of the kidney to fuse with the sheath of the opposite side, the posterior one merely joining the fascia of psoas and quadratus lumborum of the same side. Above, the sheaths fuse and are attached to the diaphragm. Below, they are lost in the pelvic fascia. The sheath is connected by fibrous bands to the perinephric fat. Externally to the renal fascia is an extensive accumulation of fat over the outer and lower part of the kidney—the paranephric fat. These layers of fat and fascia, associated with good tone of the abdominal musculature, form the chief supports of the kidney. The lieno-renal and costo-colic ligaments are said to be additional supports for the left kidney. It seems reasonable that the shape of the thoracic cage also plays its part.

The important surgical facts regarding blood supply are that there may be an aberrant renal artery which usually supplies the lower pole of the kidney, passing in front of or behind the ureter. Very rarely, gangrene of the kidney may result from cutting this artery. Furthermore, there is a coronal plane of the kidney just posterior to the mid plane, which is relatively bloodless and, therefore, of value in operations on the kidney.

The nerve supply is derived from the renal plexus, which is situated along the course of the renal artery. It consists of ganglia and fibres, deriving their supply from neighbouring plexuses—coeliac, aortic, adrenal, the lowest splanchnic and vagus nerves and a few lumbar fibres. The main afferent supply is from the tenth to the twelfth thoracic segments of the cord. Many myelinated, as well as unmyelinated, fibres are seen in the renal pelvis and calyces, but in the kidney substance, few but unmyelinated ones are seen.

Renal Pain.

This is usually felt posteriorly between the twelfth rib and erector spinae muscle, or in front at the junction of the costal margin and mid-Poupart line. It is often associated with deep tenderness. Various stimuli will cause renal pain. Pressure on a normal kidney by squeezing between the hands, results in a sickening pain of visceral origin. Inflammation of the kidney substance, as in Bright's Disease, causes pain of the same origin. It was formerly thought to be due to stretching of the capsule, but has been found associated with small sclerotic kidneys. Furthermore, the capsule is not sensitive, according to Lenander. Coarse mechanical stimuli to the pelvis or calyces, as may be associated with stone or passage of a c atheter, will cause pain, probably of somatic origin. Contraction of the musculature of pelvis, calyces or ureter, associated with obstructions, causes severe wave-like exacerbations of pain associated with

sweating, vomiting and radiation of the pain toward the inguinal region, and testicle or labium of the same side. The flank is rigid and tender, and the testicle tender and retracted. This type of pain is termed renal colic or Dietl's crisis, depending on whether it be due to stone, blood clot or, on the other hand, to kinking of the ureter, as in moveable kidney. In the latter case, the pain is not often as severe as the former, and morphine is not required. The pain is said occasionally to occur on the opposite side from the lesion, but Kuntz believes there is always an exciting cause on the same side, such as a stone too small to show in an X-ray picture. Traction or squeezing of the renal pedicle will cause pain, due to irritation of the parietal peritoneum, which is very sensitive in this area.

Incidence.

The incidence of inflammatory diseases of the kidney depends on impaired local resistance, rather than on the presence of infective bacteria. This may be due to obstruction of urinary outflow, or congestion as the result of menstruation, pregnancy, catheterization, sexual activity, alcoholic excess, or irritant drugs. The capillary system of the kidney is an excellent place for the lodging of pyaemic emboli. The organisms involved are, in 90 per cent. of cases, B. Coli. Staphylococcus aureus, Streptococcus, and tubercle bacilli are not uncommon agents.

Pyelonephritis.

This is a suppurative infection of both pelvis and kidney substance. The route of infection may be urogenous, hematogenous, or by direct extension. The first type is due to obstruction from causes such as prostatitis, calculus, new growth, pelvic inflammation or nervous disorders of the bladder. The hematogenous route may be associated with septicaemia as in typhoid, but more commonly with pyaemia. The primary focus may be a mastoiditis, furunculosis, when the pyelonephritis develops weeks later, tonsillitis or appendicitis. Direct extension may be from wounds of the kidney, appendiceal abscess, pericolic abscess, or any retroperitoneal abscess. This last type is usually unilateral and not so serious as the others.

The *pathological changes* vary from simple catarrh to extreme suppuration. The kidney is red and swollen early. The mucous membrane of the pelvis, calyces and ureter is swollen and hyperaemic. Cortical abscesses appear which may be pinpoint or coalescing, and suppurating striae in the medulla, with haemorrhagic and oedematous patches. The capsule becomes thick and strips incompletely and with difficulty. There is increased fibrous connective tissue and small round cell infiltration. If chronic, the kidney is shrunken to half its size and embedded in the perirenal fat. The pelvis and calyces are dilated if obstruction has been present.

The *symptoms* depend on whether it is acute or chronic, catarrhal or suppurative. The acute suppurative type may be fatal in a week. There are rigors, a temperature of 105°, a dry, coated tongue, vomiting, headache, delirium. There is often diarrhoea. Abdomen and loin show pain and tenderness. The urine is scanty and turbid with pus, blood and albumin. Blood culture during a rigor is positive. In children, recurrent high fever and chills are present.

The *differential* diagnosis is from typhoid, pyaemia, septicaemia and acute Bright's disease.

The disease may be chronic, the patient having suffered exacerbations and remissions for years. There is complaint of pain in muscles and joints, dull ache in the sides and the general symptoms of uraemia, such as headache, anorexia, thirst, flatulence, constipation, diarrhoea, anaemia, slowed cerebration, mental wandering, muttering, or even coma. There is polyuria with frequent, paintful micturition and sometimes haematuria. In children, recurrent digestive disturbances and slight fever should suggest this.

Signs are tenderness of the loin in an acute attack, pyrexial periods, occasionally abdominal tumour, and urine showing pus, blood, albumin and bacteria. Cystoscopy shows a uretric orifice that is inflamed, oedematous, enlarged, distorted, with turbid urine issuing. There may be a trigonitis with ulceration. Fifty per cent. of diagnoses are said to be wrong without this measure. Chromocystoscopy is useful to show the state of urinary efficiency of each kidney.

The *treatment* varies with the acuteness of the case and whether it be unilateral or not. In acute cases, the treatment is that of uraemia. If necessary, the better kidney may be drained. In unilateral cases, nephrectomy is advisable. In chronic, bilateral cases, the treatment is to remove the cause. This may be preceded by measures to reduce the infection, such as rest, fluids, urinary antiseptics, vaccine and a ketogenic diet. The bladder may be washed out and drained for a time.

The *prognosis*, except in unilateral cases, is at best, recovery with damaged kidneys and chronic cystitis.

Pyonephrosis.

This is the condition when, with septic pyelitis or pyelonephritis, obstruction to urinary outflow exists. It may be the terminal stage of renal suppuration or the result of infected hydronephrosis. The commonest causes are stone in the ureter or kidney, and tuberculosis. Routes of infection are the same as in pyelonephritis.

The *pathological* specimen may show a small kidney sitting on a large pelvis, or the kidney stretched out over the pelvis. The kidney and pelvis are the walls of a bag of pus, uniform, globular or oval in shape. The surface is irregular, bulging and thin, with pus shining through. The interior shows loculations which are usually communicating and lined by granulation tissue. Ureteritis depends on whether the infection be ascending or descending. There may be adhesions to perinephric fat, peritoneum, colon or duodenum. Occasionally the sac may rupture into the colon with symptomatic cure; into the coelomic cavity resulting in peritonitis; retroperitoneally, resulting in abscess, cellulitis or pyaemia; or externally, through the body wall.

Symptoms may have been present for a long time before the patient comes for treatment. They point to the cause, and also previous symptoms and signs of pyelitis or pyelonephritis will have been present. Pain and aching in the loin, especially at night, are complained of, while intermittent attacks of fever are always present. The symptoms may be acute, with infected hydronephrosis or polycystic kidneys.

Signs.—The patient looks weak and thin, presenting a picture of urinary septicaemia. There is a large, hard, tender, palpable kidney, usually fixed. Unless the urine is blocked, there will be pyuria and the urine is often scanty and highly coloured. X-rays may show calculi or enlargement. Cystoscopy may show enlarged ureteric orifice, distorted and hyperaemic, with turbid urine or pus. Chromocystoscopy is valuable to show which is the better kidney.

In the presence of known mechanical obstruction to the urine, any sudden attack of pain in the kidney area, especially with high fever, should suggest pyonephrosis.

The *treatment* in bilateral cases is to find and remove the cause. In unilateral cases, nephrectomy is usually done where the disease is advanced, or where the cause cannot be removed. Where the kidney is too big for easy removal, or where adhesions are considerable, nephrostomy is advisable. In mild cases, nephrostomy associated with removal of the cause, is the best method.

Perinephritis.

This condition is usually of extra-renal origin. The source is most commonly furunculosis, tonsillitis, carbuncle, scarlet fever, osteomyelitis. It may arise from acute osteomyelitis of a transverse process of a lumbar ver-

tebra, from Pott's disease, from rupture of stomach, duodenum, colon or from a retrocaecal appendix. Trauma may cause direct introduction of organisms, or result in extension from an infected kidney or cause a haematoma which later becomes infected. A renal type is rare.

Pathologically, a small collection of pus forms, or a large abscess, extending up to the diaphragm or down into the pelvis. When it is of renal origin, it is not so large as otherwise. If in the upper pole, it may give rise to empyema and be coughed up. It may extend into the pelvis. It may be retrorenal, bulging into the loin and pointing at the triangle of Petit. If anterior, it may rupture into peritoneum or colon.

It may be weeks before *symptoms* are marked, or they may be acute at first. Pain is acute, stabbling, and is accompanied by fever, malaise and vomiting.

Signs of muscular rigidity and tenderness are marked. The hip may be flexed, and in time a palpable, hard, tender, fixed swelling will be formed. Fluctuation is difficult to observe, and the tumour has not the shape of the kidney. Occasionally haematuria is present, but in the common primary form, the urine will be normal. The patient will be seen to walk, flexed toward the painful side. In neglected cases, the swelling will come to the surface and redness and oedema will be seen. X-rays are valuable to show the presence or absence of stones, size of the renal pelvis, or bone disease. Leukocytosis will be seen, except in tuberculous cases.

The *treatment* is to incise the loin outside the erector spinae muscle, and drain for a few days. If the kidney be grossly diseased, this must also be drained, followed by nephrectomy to prevent the persistence of a sinus. In tuberculous cases, incise without drainage, and treat the underlying disease.

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LYMPHATICS OF THE HEAD AND NECK.

By OSCAR HOFFMAN, '39.

Lymphatic drainage in the head and neck follows, in a general way, the course of venous drainage. From a complex network of capillaries, the lymph flows away through the most convenient channels, so that, instead of a single group of nodes receiving all the lymph from a region, adjacent groups share the drainage as well.

The number and position of the lymph nodes is variable, and their classification into groups is in many cases arbitrary.

Lymph Glands of the Head.

These may be grouped as follows:

1. *Occipital*: One or two nodes, lying over the insertion of the Trapezius muscle in relation to the great occipital nerve.

2. *Post-auricular*: Usually two nodes, lying on the mastoid insertion of the sternocleidomastoid.

3. *Pre-auricular*: One to three nodes, with a constant position immediately anterior to the tragus, superfical to the parotideo-masseteric fascia.

4. *Parotid*: A group of glands lying both within the substance of, and deep to, the parotid gland.

The efferents of these four groups drain to the superior group of deep cervical nodes, either directly or via the superficial cervical glands.

5. *Facial*:

(a) Superficial glands, grouped according to their positions as:

(i) infra-orbital.

(ii) buccinator, lying on the Buccinator muscle opposite the angle of the mouth.

(iii) supramandibular, on the outer surface of the mandible, in contact with the anterior facial vein.

(b) Deep glands, beneath the ramus of the mandible on the External maxillary artery.

The facial glands drain to the superior group of deep cervical nodes either directly or via the submaxillary nodes.

Lymph Glands of the Neck.

1. *Submental*: Three or four glands lying in the digastric triangle. The efferents pass to the superior group of deep cervical nodes directly, or via the submaxillary nodes.

2. *Submaxillary*: A group of nodes between the lower border of the ramus of the mandible, and the submaxillary salivary gland. One of this group—the gland of Stohr—lies in the S-shaped bend of the external maxillary artery as it crosses the mandible. These glands drain to the superior group of the deep cervical chain.

3. *Superficial Cervical*: Lie superficial to the Sternocleidomastoid, along the external jugular vein. They drain to the superior group of deep cervical glands.

4. *Anterior Cervical*:—

(a) Superficial glands along the anterior jugular vien, which are inconstant, and of no great importance.

(b) Deep glands, grouped as follows:

(i) Infrahyoid: in front of the thyreohyoid membrane.

(ii) Pre-laryngeal: on the cricothyreoid ligament.

(iii) Pre-tracheal: in front of the trachea, in relation to the inferior thyreoid veins.

The anterior cervical glands drain to the deep cervical chain.

5. *The Deep Cervical Chain*: This important chain is made up of a number of large glands lying along the carotid sheath, from the base of the skull to the

root of the neck. They may be grouped as follows:

(a) Superior deep cervical glands: Lying close to the internal jugular vein above the level of the bifurcation of the common carotid artery. The efferents of the superior deep cervical glands go to the jugular trunk either directly or via the inferior deep cervical glands.

(b) Inferior deep cervical glands: (supraclavicular nodes). Lying behind the lower part of the Sternomastoid, and extending into the subclavian triangle, into relation with the brachial plexus and subclavian vessels. These glands receive lymph directly or indirectly from the major portion of the head and neck, and in addition, from the superficial pectoral region and the lateral part of the arm and fore-arm. They also receive some efferents from the axillary nodes.

(c) Retropharyngeal glands are simply outlying glands of the cervical chain, which lie on the prevertebral layer of cervical fascia, behind the pharynx.

Four of the glands of the deep cervical chain may be given particular recognition:

(a) The adenoid glands, below the tip of the mastoid process, under cover of the Sternomastoid.

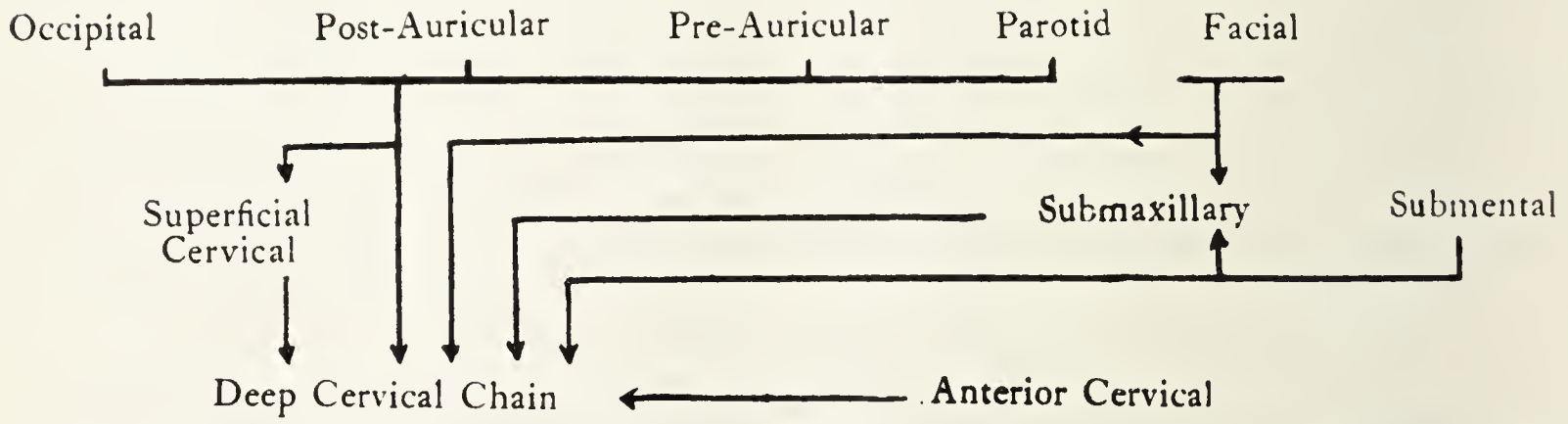
(b) The jugulo-digastric, or main gland of the tonsil, situated in the angle between the internal jugular and common facial veins.

(c) The main gland of the tongue, at a little lower level, i.e., at the bifurcation of the common carotid artery.

(d) The jugulo-omohyoid gland, on the common carotid artery just above the level at which the anterior belly of the Omohyoid crosses the artery.

The lymph vessels from the deep cervical chain form, on each side, the jugular trunk. That on the right enters the junction of the subclavian and internal jugular veins. That on the left enters the thoracic duct.

The flow of lymph through the glands of the head and neck is represented in the following outline:



Lymph Vessels of Head and Neck.

A. Superficial Structures.

1. *The scalp*: The vessels pass down from the vertex and are distributed as follows:

(i) frontal region to parotid nodes.

(ii) temporal and parietal areas to parotid, pre-auricular and post-auricular nodes:

(iii) occipital area to the occipital nodes, and also, by a direct trunk along the posterior border of the Sternocleidomastoid to the inferior deep cervical nodes.

2. *The eyelids*: (the conjunctiva, being part of the integument has lymphatic vessels which accompany those of the eyelids). The capillary plexus is dense in this region, particularly at the free margins of the lids. The lymph from the medial one-quarter of the lids drans obliquely across the cheek to the facial and submaxillary nodes, while

that from the lateral three-quarters passes to the anterior auricular and parotid nodes.

3. *The nose*: Those from the root drain to the parotid glands, while the dense alar network drains to the facial and submaxillary glands. Anastomoses exist between the lymphatic capillaries of the skin and those of the nasal mucosa.

4. *The lips*: The lymph plexuses of the skin and mucous membrane are continuous at the free borders of the lips. The central area of the lower lip drains to the submental glands while the remainder of both lips drains to the submaxillary glands.

5. *The auricle,* external auditory meatus, and surface of the tympanic membrane: the lymph passes to the adjacent glands in three general directions:

(i) Both surfaces of the auricle, and the posterior part of the external meatus, to the post-auricular nodes.

(ii) The tragus, and anterior part of the meatus to the pre-auricular nodes.

(iii) The lobule, helix, part of the concha, and floor of the meatus, to the superficial cervical and superior deep cervical nodes.

B. Deep Structures:

1. *Drainage of Waldeyer's Lymphatic Ring*:

This ring is a circle of lymphoid tissue about the entrance to the pharynx. It is formed above by the pharyngeal tonsils (adenoids); below by the lingual tonsil; and laterally by the faucial tonsils, or simply "tonsils." Scattered lymphoid tissue completes the ring. Drainage takes place by way of the jugulo-digastric (tonsillar), and adenoid glands, both members of the superior deep cervical group.

2. *The tongue*: Characteristic of the mucous membranes of the oral and nasal cavities, the lymphatic capillary plexus of the tongue is a rich one. Four groups of collecting vessels are found:

(i) Apical vessels run from the tip of the tongue along the frenulum and end in various glands, including the submental, suprahyoid, submaxillary and deep cervical (jugulo-omohyoid) glands. It may be observed that the anterior efferents reach glands situated at a lower level than the vessels from the back of the tongue.

(ii) Marginal vessels: The anterior marginal vessels drain to the submaxillary nodes, while those further back, including the area behind the circumvallate papillae, pass to the superior deep cervical group, particularly the jugulo-digastric and jugulo-omohyoid glands.

(iii) Central vessels: These share the drainage of the dorsum with the marginal vessels. They descend through the tongue between the Genioglossi, and turning to either side, reach the superior deep cervical glands.

(iv) Basal vessels: These drain to the upper part of the superior deep cervical chain (jugulo-digastric), and also to the tonsillar glands.

It is important to observe that those portions of the tongue whose efferents leave by the apical, central, or basel vessels, send a part of their lymph to the nodes of the opposite side, due to the manner in which the efferent vessels decussate in the midline of the tongue.

3. *The palate*: Both the hard and soft palates drain to the superior deep cervical nodes, though some vessels from the latter end in the retropharyngeal nodes.

4. *The pharynx and Eustachian tubes* drain to the superior deep cervical glands directly or via the retropharyngeal glands.

5. *The larynx* is drained by two sets of vessels. Those from above the ventricular folds drain to the superior deep cervicals, while those from below the folds pass to the inferior deep cervicals,

and to the pretracheal and prelaryngeal glands.

6. *The nasal cavities* have vessels which communicate anteriorly with the subcutaneous vessels of the skin, and posteriorly, drain to the retropharyngeal glands. Injection of the nasal lymphatics may be made by injection of the subarachnoid space at the base of the brain, the connection likely occurring via the perineural spaces about the olfactory nerve fibres.

7. *The temporal and infratemporal fossae* drain to the deep facial glands.

8. *The thyreoid gland* sends efferents to the deep cervical chain and also from its lower part, to the pre-laryngeal and pretracheal glands.

9. *The trachea and oesophagus* drain chiefly to the inferior deep cervical nodes.

10. *The eyes* No lymphatics have been demonstrated in the eye-ball or orbit. However, tissue spaces in the orbit, and about the optic nerve, communicate with the subarachnoid space of the cranial cavity.

11. *The brain* has no recognized lymphatics. Perivascular and subdural tissue spaces contain lymph, and it is supposed that absorption is accomplished by the veins.

THE SKELETAL SYSTEM.

By J. G. MICKLER, '41.

The skeletal system has, in general, a three-fold function. It provides a framework supporting the whole body, serves as a protection and support for the soft parts, and, through muscle action, provides a means of locomotion.

This system is largely made up of cartilage and bone—so that it would be well to first consider these tissues.

Cartilage — as well as bone, is a form of connective tissue, originally derived from mesenchymal cells. Masses of mesenchyme are arranged in the tissues of the embryo, and by the differentiation of these cells into chondroblasts, cartilage is formed—the chondroblasts laying down the characteristic hyalin matrix, and coming to lie in lacunae, become cartilage cells. The plate thus formed reaches its ultimate proportions first by Interstitial growth, whereby the cartilage cells themselves proliferate, and expand the plate, and secondly, by Appositional growth, which is brought about by the differentiation of osteogenic cells into chondroblasts and then into cartilage cells. Osteogenic cells are mesenchymal cells that have differentiated only to the stage where they can differentiate further into chondroblasts or osteoblasts (bone forming cells). The cartilage thus formed is surrounded by a sheath known as the perichondrium, consisting of an inner layer of osteogenic cells, and an outer layer of fibrous tissue.

Bone—is of two types, cartilaginous bone and membrane bone. Cartilage bone is not formed from cartilage, but is simply laid down on the remains of the original cartilage, which it replaces. This process is begun by the calcification of the matrix of the cartilage, resulting in the death of the cells, due to lack of nourishment, and the formation of large spaces within the cartilage. Into such a space there grows a bud of osteogenic cells and capillaries from the perichondrium. The osteogenic cells at once differentiate into osteoblasts and lay down the organic bone matrix on the surviving cartilage. In this way, spongy or cancellous bone is formed. In addition, the osteogenic cells of the perichondrium, called the periosteum at this stage, have already begun to differentiate into bone-forming cells, and to lay down bone. This is sub-periosteal bone. The organic bone matrix thus formed becomes calcified, in each case, to form normal bone.

In long bones, the ossification centre

—that area into which the bud has grown—spreads along the bone shaft, while, as a rule, additional centres appear in the cartilage outlining the future ends of the bones. In this way, the whole becomes transformed into bone, except for the articular cartilage on the epiphyses (ends of the bones) and a plate of cartilage called the Epiphyseal plate, between shaft and epiphysis. The plate is an ingenious arrangement allowing the bone shaft to increase in length, for bone cells cannot divide and expand the bone. At the surface of the plate nearest the shaft, the cartilage cells are replaced by bone, while at the epiphyseal side, this loss is compensated by proliferation of the cartilage cells, so that the plate remains of constant thickness until the bone has reached its ultimate length. The plate is then replaced by bone, its position corresponding to the epiphyseal line of the long bone.

This bone is spongy bone and is first transformed into bone having Haversian canals, for the passage of blood vessels and nerves. This is done by the laying down of additional lamellae of bone by the osteoblasts formed from osteogenic cells, within the tunnels formed by degeneration of the original cartilage. These lamellae line the walls of the tunnel, reducing the cavity to a narrow canal—an Haversian canal. The sub-periosteal bone, which is of a compact sort, is added to by the osteogenic layer of the periosteum, and Haversian canals are formed in it as the bone is laid down. The shaft then becomes quite thick. Thereupon, by a chemical process of absorption of the bone within the shaft, and a laying down of peripheral bone, the shaft is widened, and the marrow cavity is created. The shaft is then composed completely of compact bone, although the inner bone of the epiphyses remains cancellous. Smooth layers of fine bone then laid down within and upon the outside of the bone, complete the process.

Membrane bone is formed by the direct differentiation of osteogenic cells into osteoblasts. Such bone is found in the lower jaw, and in the flat bones of the sides and roof of the skull. The bone is laid down in two parallel plates, and as growth is needed, e.g., to accommodate the developing brain, a process of absorption and re-laying-down is carried on to enlarge the vault of the skull.

The Axial Skeleton.—The axial skeleton comprises the vertebral column, skull and visceral skeleton, as well as the ribs, sternum and pelvic and pectoral girdles.

The notochord serves as the primitive backbone in all vertebrates, and, although almost wholly obliterated in man, it remains in Elasmobranchs as the final backbone strengthened by cartilage. In higher vertebrates the notochord is replaced as a supporting structure by the vertebral column, consisting of individual segments, or vertebrae, strongly laced together by ligaments, to form a sturdy but flexible supporting structure. The vertebral column also serves to protect the nerve cord.

Vertebrae are formed from the sclerotomes of the somites—those metameric blocs of mesoderm seen early in development. These sclerotomes become divided tranversely into halves, and contiguous halves of adjacent sclerotomes become fused together. This arrangement brings about the alternation of myotome (the muscle-forming part of the somite) and sclerotome, which is necessary in order that the fibres of muscle derived from the myotome be useful in moving the vertebrae. The structures thus formed fuse across the mid-line, thus obliterating the notochord, and forming the bodies of the future vertebrae. Then, two processes are sent dorsally from each body, to arch around the nerve cord, and fuse together, sending out a dorsal spine at their junction. A ventral, or haemal arch, for the protection of bloodvessels, is sometimes found in lower forms. From the dorsal arch, two transverse processes and two articular processes also project, and costal processes as well. This mesenchymal tissue now

becomes transformed into cartilage, and this is replaced by bone. This typical plan of a vertebra consisting of a cylindrical body and neural arch, from which two transverse processes project laterally, a median spine projects dorsally, and from which spring two articular processes, bearing facets, at the junction of the arch and body superiorly and inferiorly, is generally followed, but often modified. For instance, in the cervical vertebrae, of which there are seven in man, the first, the atlas, possesses no body or dorsal spine, while its anterior surface bears two large concave plates for articulation with the occipital condyles of the skull. The body of the atlas has become appropriated by the axis, as the odontoid process. All the cervical vertebrae have rudimentary ribs, which, passing from their transverse processes to their bodies, form the foramen transversarium. The twelve thoracic vertebrae are characterized by their long dorsal spines, and by the fact that fully developed ribs articulate with them by means of facets attached to their transverse processes, and demi-facets borne by the sides of their bodies. The five lumbar vertebrae have broad, deep bodies, since they support a great deal of the weight of the human body. The five sacral vertebrae have become fused, to form the sacrum, to which the pelvic girdle is attached. The caudal vertebrae have degenerated to form the coccyx.

The vertebral column is enabled to protect the spinal cord by means of the vertebral canal, this canal being formed by the aggregation of the vertebral foramina formed by the neural arches of all save the caudal vertebrae.

The thoracic ribs, twelve in number in humans, are originally outgrowths of the sclerotome, which curve ventrolaterally to encircle the body. They then break away from the embryonic vertebral bodies, and as chondrification and then ossification goes on, joints are formed at this breaking-point so that the head of each rib articulates with the facets provided for it on the vertebral bodies, and the tuberculum of each (a knob near the vertebral end of each rib) articulates with a facet on the transverse process. The ventral ends of the ribs, however, remain cartilaginous, and only the upper seven or eight are directly attached to the sternum, the remainder either attaching to the so-called true ribs, or becoming free ventrally, to be known as floating ribs. Rudimentary ribs are found in the cervical, lumbar, and sacral regions, where they form bars immediately ventral to the transverse processes, forming the foramen transversarium of the cervical vertebrae, and thickening the transverse processes of the lumbar and sacral vertebrae. The ribs enclose the thorax, thus effectively protecting the heart and lungs and, by outward and upward movement, the ribs aid the diaphragm in inspiration.

The sternum is formed by the fusion of two bars of cartilage formed by the union of the cartilaginous ventral ends of the first seven or eight thoracic ribs. The plate thus formed is then ossified, its cephalic portion becoming the manubrium sterni, to which two episternal cartilages ossify and attach themselves, for articulation with the clavicles. The caudal part of the plate remains cartilaginous to become the xiphoid process. Ribs articulate with the sternum by means of articular surfaces placed along its sides. The sternum is very useful, in that it welds the thoracic skeleton into a firm, protective unit.

Skull and Visceral Skeleton.—For a clear and concise description of the development of the skull, and of the fate of the visceral skeleton, see the article by Clement McCulloch, '39, on page 81 of the December issue of this journal.

Pelvic and Pectoral Girdles. — The pelvic and pectoral girdles are the intermediary bones between body and limbs, and are each originally made up of three bones on each side, converging at the point of articulation with the limb. The bones of the pelvic girdle are serially homologous with those of the pectoral girdle—the ilium corresponding to the scapula, the ischium to

the coracoid, and the pubis to the procoracoid, a process of the pectoral girdle that has disappeared in mammals, but which is found in reptiles.

The pectoral girdle does not articulate directly with the vertebral column, but is fastened to the thoracic basket by muscles and ligaments, and in man and higher mammals, it articulates with the sternum by means of the clavicle. This arrangement gives the anterior (upper) limb great range of movement —for the scapula can move about on the thorax to a certain degree. The triangular scapula is formed on the dorso-lateral surface of the thorax, and the coracoid process projects forward from the upper lateral angle of the scapula, just above the glenoid cavity. The spine of the scapula, beginning at its medial border and proceeding laterally, ends in the acromion, a flattened projection directed forwards and somewhat overhanging the glenoid cup. The clavicle is of debatable origin, but it seems to be a membrane bone, a newly-developed structure in the animal series. The clavicle connects the acromion of the scapula with the sternum, and is a short, somewhat S-shaped bone passing between the acromion and a notch on the manubrium, and serving to transmit part of the weight of the limbs to the axial skeleton, and to brace the scapula back, allowing freer movement of the upper limb.

The pelvic girdle is formed of the two hip bones, each of which consists of three elements arranged in tripod fashion, with the acetabulum, a deep cup-shaped fossa articulating with the head of femur, situated at their centre of radiation. The elements of this girdle—ilium, ischium and pubis, are preformed in cartilage, ossify, and become associated together at the acetabulum, while the ischium and pubis unite to enclose the obturator foramen. The wide ilium articulates directly with the sacrum, while the pubic bones of each side become united, anteriorly, at the pubic symphysis. The two hip bones, together with the sacrum and coccyx, constitute the pelvis.

The pelvic girdle is directly attached to the backbone, for its main function is that of supporting the body weight upon the lower limbs. The pelvic girdle is built for strength, as opposed to the pectoral girdle, which is built for freedom of movement.

The Appendicular Skeleton. — The anterior and posterior limbs are derived, throughout the animal series, from the paired pelvic and pectoral fins. These appendages are serially homologous, for, in the human, the humerus, radius and ulna, carpus and digits, of the upper limb correspond to the femur, fibula and tibia, tarsus and digits, of the lower limb. The bones of the appendages are long bones, with the exception of those of the tarsus and carpus, and as such are laid down in mesenchymal models, in the limb-buds of the embryo. Before these models are turned into cartilage, the blastema disappears at the points where future joints are to occur. Then chondrification goes on, followed by ossification. The patella of the knee, and pisiform of the carpus, are sesamoid bones, that is, they are developed in the tendons, as a result of the rubbing of the tendon upon a bony surface.

The primitive position of the limbs, consisting, anteriorly and posteriorly, of a horizontal, laterally-directed segment articulating with a vertical middle segment that articulates, in turn, with a distal part contacting the ground and pointing in the same direction as the proximal segment, has been modified, in man, although this set-up is found in lower forms of animal life. The upper (anterior) limb has been rotated backward through 90°, and the hand forward through 180°, whereas the posterior limb has been moved forward through 90°. By this arrangement the limbs have been drawn in, through the animal series, beneath the body, to form an adequate support for it, and to facilitate speedier, more positive movement.

The Teeth.—The teeth may be considered part of the exoskeleton, and are produced by the combined efforts of

ectodermal epithelium and mesenchyme. Mammalian teeth are borne only by the upper and lower jaws. In the embryo, the groove dividing the ectoderm covering the lip from that of the developing jaw, is continued into the mesenchyme of the jaw as several processes of epithelium, known as dental ledges. Buds or enlargements appearing at the ends of these ingrowths indicate the beginning formation of the milk (decidual) dentition. These buds of epithelium are known as enamel organs, since they produce the enamel covering the crowns of the teeth. The mesenchyme, invaginating such a bud, grows into it as the papilla. The epithelial cells of the enamel organ, next to the papilla, become columnar and lay down the enamel—the hardest substance found in the body. The cells within the enamel organ itself constitute the enamel pulp, which is soon obliterated. The cells of the papilla, adjacent to the enamel organ, also become columnar, and lay down a membrane, which develops, by calcification, into the hard dentin, forming the pulp of the tooth. The dental sac, a vascular sheath of connective tissue, encloses the developing tooth as this process goes on. The root of the tooth is formed by a down-growth of the epithelial bud known as the epithelial sheath, which is covered by the dental sac, and in which osteoblasts begin to form bone. The formation of the root drives the crown of the tooth out through the gum, thus rupturing the dental sac. The cement, formed from this sac, to hold the lower part of the tooth in its place in the alveolus of the jaw, is really true bone with no Haversian canals.

Permanent teeth are developed in the same general way, from outgrowths of the original epithelial ingrowths. These develop deep to the decidual teeth, and replace them as required.

There are in man, in each jaw, four incisor teeth, designed for cutting; two canine teeth, large and strong; four premolars, and six molars, the crowns of the latter being broad and strong, adapting them for crushing food.

Joints.—The various joints or articulations of the body join the bones together, allowing wide range of movement, when necessary, and preventing it when undesirable.

There are three main types of articulation—(a) Fibrous joints, represented by the sutures of the skull, where the bones are joined together by fibrous tissue and no appreciable movement is possible. (b) Cartilaginous joints, in which the opposed bone surfaces, covered by hyalin cartilage, are joined together by a disc of fibrocartilage, as in the articulations between the vertebral bodies and between the pubic bones. (c) Synovial joints: This type of joint is found in all the joints of both limbs, except the pubic symphysis, and a fibrous joint between the inferior ends of tibia and fibula. In a synovial joint, the articulating bone surfaces are covered by hyalin car-

Too Well Known to Require Added Praise.

Dr. Boyd's Three Works

"Pathology of Internal Diseases".....2nd Ed., 1935
"Surgical Pathology".....3rd Ed., 1933
"Textbook of Pathology".....2nd Ed., 1935

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tilage, and the whole joint is surrounded by a fibrous capsule, and accessory ligaments, enclosing a joint cavity which contains synovia, a lubricating fluid secreted by the synovial membrane which lines the capsule.

There are several types of synovial joints depending upon the sort of movement required. The ball-and-socket type allows great range of movement, as in the shoulder and hip joints. The hinge joint permits motion in one plane only—shown by the humero-ulnar and interphalangeal joints. The pivot joint, seen in the articulation of the odontoid process of the Axis with the arch of Atlas, limits movement to rotation. The Condyloid type allows every sort of movement except axial rotation. Plane joints, such as occur between the articular processes of the vertebrae, allow only sliding movement to take place.

This general survey, sketchy though it may be, should present the skeletal system as admirably complete and adequate, when the demands made upon it are considered. The fact that this system is very strong, yet sufficiently light and flexible, makes it easily capable of carrying out its functions of support, protection and locomotion.

FEATURE SECTION

A Summer at Harrington Harbour, P.Q.

By J. D. Caldwell, '37.

In the last issue of this "Medical Journal," there was a short article by W. R. Feasley, '37, describing some of his experiences in the most westerly community in Canada. During this past summer, I had the privilege of being in the most easterly hospital in Canada —at Harrington Harbour in the Canadian Labrador. It is about 800 miles north-east of Quebec City on the north shore of the Gulf of St. Lawrence.

About thirty years ago, Sir Wilfred Grenfell established one of his numerous hospitals at Harrington Harbour, so that the fishermen along this coast of the Gulf could be given medical assistance. The remainder of his hospitals are in Labrador or Newfoundland. The hospital is a large frame building, which can accommodate thirteen patients, as well as the nurses and kitchen staff. It is well equipped, having an operating room, X-ray and fluoroscopic machine, a dental chair, an office for the doctor and a dispensary. The staff of the hospital consists of one doctor (Dr. Donald Hodd, Toronto, '26), two nurses and maids. In addition, during the summer, there are a medical student, a dentist and two "Wops." The latter are college students, who do outdoor work in connection with the hospital.

The hospital is situated on the largest of five islands, which are so arranged that they form a natural harbour, with shelter in all directions. There are no trees on the islands and the only growth consists of shrubs less than three feet tall, moss, numerous varities of berries and wild flowers. Some of the people attempt to grow vegetables, but have little success.

In the village of Harrington, there are about 400 people. They are descendants of the Grand Bank fishermen from Newfoundland. Along the coast in either direction, there are numerous small settlements of the same type of individuals, and, in addition, there are three villages of French-Canadians. During the summer, the people fish for cod, salmon and lobster, while in the fall and spring they hunt seals. In the winter time, there is a limited amount of hunting on the mainland, five miles away. These people live in frame houses, the majority of which are painted and well built. The poorer houses are often papered on the inside

with magazines and old newspapers. In every house there is always a picture of a former King and Queen. Each family have a "stage" of their own, which is a small shack down by the edge of the water, where they clean and store their fish. Wherever you go, you will see dogs of the husky variety, which are used for travel during the winter. In the summer, these dogs are tied up to prevent them from destroying the fish laid on the rocks to dry.

There were also three bands of Indians, which came under our care. These tribes are nomadic and come to the Hudson Bay Co. posts in order to trade their furs. They live in square canvas tents, which are heated by a small stove in the middle of the tent. The filth and dirt of these tents was disgusting, and the only pleasing part of them was the floors of fresh spruce boughs. In the winter time, the Indians travel several hundred miles inland to their hunting grounds.

Tuberculosis is the commonest disease found along the coast, in spite of the fact that the people are out in the open air a great deal of the time. I believe that the greatest factor contributing to this condition is their inadequate diet, for the majority of them are very poor. All types of disease are seen along the coast, with the exception of the venereal diseases, which are very rare.

All travel along the coast is by boat, and the doctor endeavours to cover his territory early in the summer and then send his assistant on a cruise later. From our station, we had to look after the coast 125 miles to the west and 200 miles to the east. All serious cases, which cannot be treated in the homes, are brought to the hospital. This summer, the doctor was away on his trips longer than usual, as he was held up by stormy weather, and I was left in charge of the hospital during most of July and August. Fortunately, no serious emergencies were brought in.

While in Harrington, it was my duty to call on the sick patients who could not come to the out-patient service, prescribe drugs and try to keep them in bed. In order to go over to the other islands, we had to use a slow motor-boat, and often a whole morning would be taken up making two calls. During the summer, there was an epidemic of "flu" and several of the children developed acute atitis media. A great number of them had perforated ear drums before we were called in and as a result, we had several discharging ears to treat for quite a while.

I was sent out on several trips along the coast, and on one, I went 65 miles to see an Indian woman, who had failed to expel the placenta following labour. Another time, I went 125 miles down the coast on an "emergency" call. I received a telegram late one afternoon telling me to go down and see this patient. As the doctor was away in the hospital boat in the opposite direction, it was necessary to hire a fisherman to take me in his 25-foot, open boat. This boat had a 6-h.p. engine in it and travelled at the rate of seven miles an hour. We made arrangements to leave early the next morning, but it became so stormy that we couldn't leave for two days. We finally got away, and it took us one and a half days of hard driving to reach our destination. I diagnosed the case as duodenal ulcer with haemorrhage, and endeavoured to put the patient in bed and on a diet. On the way home, we slept in the boat over night and the next morning we were up at 4.30 a.m. Within the next hour, we travelled out to some islands, and I called on two patients, both of whom I had to get out of bed, as it was Sunday morning. We then continued on our way and reached home late that evening.

I had many varied experiences during the summer and thoroughly enjoyed my visit. The medical experience was a very valuable training, and I saw many unusual things. If anybody wishes to spend a cool summer (the hottest day was 76°), and also have a variety of medical experience, I would advise him to go to the Labrador coast.

BOOK REVIEW

The Phenomena of Life.

By George Crile. W. W. Norton & Co. New York. 1936.

This book describes in detail the author's search over a period of many years for the explanation of surgical shock with resulting death, arising as a result of traumatic injuries in which none of the vital organs of the body showed pathological changes. In this search Dr. Crile and his associates have explored the field thoroughly, using accepted physiological methods of animal experimentation, producing injury and death by nearly every conceivable type of method and sectioning and examining histologically all of the organs of the body following death.

In every case they found correlated changes in brain, thyroid gland, and adrenal-sympathetic system which could be demonstrated histologically and also by variations in the biochemical and biophysical reactions of extracts of these tissues. The preliminary work indicated that all life processes and activities were dependent upon the harmonious working together of this system and that its action was electrical in nature.

This conclusion was followed by an intensive ten-year biophysical study, involving some 2,500 animals, in which facts were recorded, theories formed and discarded, and further facts recorded until finally they felt justified in announcing a new radio-electric theory of living phenomena, a theory which does give logical explanation to many vital processes and in which each part of the theory is backed by carefully verified experimental facts.

"The Phenomena of Life" is not a book for the lay reader. To understand the work behind the new theory a knowledge of anatomy, histology, physiology, biochemistry, biology, and electrical physics in at least their essentials is necessary. To the student who has grasped these foundation principles, however, it is a book which presents an almost entirely new theory of Life in a logical and fascinating manner and one which is well worth the time required for its perusal. E.S.P.

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